BRICS 2023 SOUTH AFRICA

ENERGY TRANSITION SKILLS REPORT 2023

BRICS ENERGY RESEARCH COOPERATION PLATFORM

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The work covers diverse skills required for the energy transition and security for BRICS countries as they shift from traditional, non-renewable sources of energy to renewable, sustainable sources of energy. There is a growing demand for individuals with specific skills to support and accelerate energy transition as the world transitions to a greener and more sustainable future. For this reason, the BRICS Energy Transition Skills Report focuses the skills and approaches for the transition.

The material was prepared by experts of the BRICS Energy Research Cooperation Platform based on the national information provided and with the active participation of relevant ministries of the BRICS countries. The study consists of three chapters, the first chapter touches on the status and progress of the labour market in the BRICS countries to support energy transition. The second chapter provides an analysis of the BRICS countries' national parts. The last chapter outlines prospects for cooperation between the BRICS countries in the development of the labour market in the energy sector, energy education and human potential.

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

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CONTENTS

FOREWORDS

Alexandre Silveira

Minister of Mines and Energy of the Federative Republic of Brazil

FOREWORD

The energy transition has been a recurring theme in global discussions, mostly associated with the need to mitigate environmental impacts and decarbonize economies. Brazil, starting from a favorable outlook with predominance of renewables in the energy and electricity matrices, has been nevertheless proactive in identifying opportunities arising from this recent perspective.

It is worth highlighting the relationship between the transition and the growing need for mechanisms to increase energy security. The energy transition can play a vital role in security, not only as a requirement - given the aforementioned need to decarbonize economies - but also acting as a catalyst for energy security itself, by allowing for the rational use of energy resources in each country, in order to ensure greater stability and guarantee of supply.

This calls for the development of a qualified workforce that can support the transition to low-carbon energy sources, such as wind, solar, biomass, hydroelectric, nuclear and others with the adoption of emission abatement technologies. It also requires investment in education and training programs that may provide citizens with the necessary skills to be an integral part of this process, especially in a scenario of growing perspectives for the renewables sector. Our country has made some progress in this field and experienced the growth of jobs in areas related to renewable energies.

Brazil is capable of being one of the vectors and proponents of this change, and we do believe that efforts and cooperation will be necessary for us to tread a more prosperous path for all. BRICS members share some similar perspectives and challenges and should work together to strengthen as well as expand cooperation in the energy sector, ensuring that we are prepared to face this call and explore our synergies. In this sense, the Energy Transition Skills report is a direct product of collaborative work within the BRICS. It shows that we are ready to participate in the global energy transition process, bringing our own perspectives regarding the use of low-emission energy, in a rational, pragmatic, but also just and lasting way.

Shulginov Nikolay

Minister of Energy of the Russian Federation

FOREWORD

Representing the world's largest energy producers and consumers, BRICS countries also form a major global repository of labour force. It is extremely important to get the maximum out of this competitive advantage. Likewise, there is an outstanding need to keep the five countries' focus on the issues related to the development of energy labour market, human resources, and extend their cooperation in that regard.

The world is now embarking on energy transition, which would eventually transform the global labour market. Our countries chose to follow that path as well. We are fully aware that such conversion would require additional measures with regards to specialists' training and professional development. Attracting young specialists to the industry and providing them with decent working conditions is of particular importance here.

Therefore, we warmly welcome the launch of BRICS study dedicated to the development of human resources in the era of energy transition. It was drafted and finalised by the experts of the BRICS Energy Research Cooperation Platform. In the process of its preparation, we have managed to summarise the best practices from our countries with regards to personnel training, as well as to form a community of experts committed to fully implement the report's recommendations, in the format of the Informal Steering Committee consisting of the representatives of BRICS energy companies, universities, as well as the International Labour Organization.

I am confident that the results of the study would serve as a solid basis for the development of energy cooperation between our countries and lead to the launch of new practically oriented projects!

Raj Kumar Singh

Minister of Power of the Republic of India

FOREWORD

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

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

[Foreword from the Energy Security Report]

Zhang Jianhua

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

FOREWORD

Representing the world's largest developing and emerging markets, the BRICS are experiencing rapid economic growth and have a high demand for energy. From 2010 to 2022, Our share in global energy consumption increased from 34.7% to 41.1%, significantly transforming the world's energy landscape. Embracing the global trend of green and low-carbon development, the BRICS are actively promoting the clean transition of energy and becoming a crucial driving force for global energy transformation.

In response to climate change, each member of the BRICS has set its own energy transition goal. China aims to increase the share of non-fossil energy in primary energy consumption to around 25% by 2030 and over 80% by 2060.

The advancement of renewable energy technologies like wind and solar power has substantially reduced the cost to generate electricity, making the green transformation of energy an irreversible global trend. In line with Xi Jinping's Thought on Ecological Civilization and his important statements on energy revolution, China is steadfastly pursuing clean and low-carbon energy transition and actively responding to the climate change. With continuous efforts, China has built the world's largest clean energy power system, with the total installed capacity of renewable energy exceeding 1300 GW, and that of the wind and solar power growing by 12 times over the past decade. Sincerely, China is willing to uphold the spirit of "Openness, Inclusiveness and Win-win Cooperation" to work alongside other BRICS countries, to strengthen clean energy cooperation, jointly promote energy transition, address climate change, and build a green, low-carbon, clean and beautiful home for the Earth.

Samson Gwede Mantashe

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

FOREWORD

BRICS country energy sectors are being driven by several key global and local trends. These trends have critical implications for skills development as current jobs are impacted together with new occupations and skills needed to support our energy transition. Our citizens and workforce continue to play a pivotal role in driving the transition of our energy systems, supporting our goal and aspirations for alternatives to cleaner sources of fuels and technologies. In our efforts to strengthen the role of the BRICS countries in global energy discussions, we must continue to work together to achieve a better quality of life for people most impacted like women and the poor through the just energy transition and investing in the development of our workforce.

The BRICS approach to energy transition skills is primarily based on the energy strategies of each country, relative to its peculiar energy sector. The BRICS countries have a common and shared goal of just energy transition, ensuring energy security through the expansion of energy access, and creating cleaner, low carbon energy systems to reduce the impact of climate change amongst others socio-economic benefits.

As the population of the BRICS countries continues to grow, the demand for energy is equally expected to follow the same trend. An inclusive approach of upskilling and reskilling our workforce through targeted training programmes and labour market development in the context of the energy transition is crucial for BRICS countries.

South Africa is pleased to present a study focused on future thinking and providing a bases for discussions and an inclusive approach towards energy transition skills. I am confident that this report will contribute towards strengthen and enhance BRICS contribution in ensuring a successful skills development in our energy transition journey. Finally, I would like to acknowledge the authors of this year's BRICS Energy Transition Skills Report and Russia as co-organisers, well done.

INTRODUCTION

Each of the BRICS countries - Brazil, Russia, India, China, and South Africa – has formulated a concrete timeframe goal to achieve carbon neutrality: Russia and China – by 2060, Brazil and South Africa –by 2050, and India – by 2070. To achieve this goal of carbon neutrality, it is widely acknowledged that new skills are needed, making reskilling of the current labour force in the energy sector a priority for these countries.

The BRICS countries possess immense potential for collaborative efforts aimed at advancing the labour market within the energy sector, promoting energy education, and unlocking human potential. By leveraging their collective strengths and synergies effectively, these nations could achieve remarkable strides in transitioning towards sustainable energy sources, thereby creating substantial employment opportunities, fostering skill development, and elevating energy education to new heights. This cooperation not only facilitates their individual energy transition but also contributes significantly to global sustainability objectives.

To grasp the magnitude of future cooperation, it is essential to recognise the significant role played by each BRICS country. As of 2021, BRICS countries represented nearly 42% of the world's population and accounted for over 23% of the global Gross Domestic Product (GDP). Moreover, China and India, among the largest consumers and producers of energy worldwide, contribute substantially to the collective energy resources. For instance, in 2019, China alone employed an estimated 20 million workers in its energy sector, highlighting the sector's vast workforce on a global scale, which was approximately 65 million, as reported by the International Energy Agency (IEA).

To harness the full potential of sustainable efforts, it becomes essential to explore the distribution and focus of skills provided by each BRICS country and determine how they can be effectively implemented to promote ongoing growth and emissions reduction globally. The existing focus on economics, trade, finance, technology, sustainable development, and global governance within BRICS provides a robust platform for cooperation that can yield significant global impacts. Notably, the transition to sustainable energy sources will act as a catalyst for job creation, as emphasised by the International Renewable Energy Agency (IRENA) report, which highlights the renewable energy sector as a significant source of job creation, with global employment potential projected to reach 42 million jobs by 2050.

One pivotal aspect of this collaboration lies in the sustainable energy transition. By pooling their resources and expertise, BRICS countries can expedite the adoption of renewable energy technologies, such as solar, wind, and hydroelectric power. The International Renewable Energy Agency (IRENA) report from 2019 indicates that the renewable energy sector employed around 11.5 million people globally, and BRICS, especially China and India, have witnessed substantial growth in renewable energy installations with investments amounting to billions of dollars. The establishment of institutions like the New Development Bank (NDB) further paves the way for the future implementation of infrastructure and sustainable developments in BRICS countries, emerging economies, and developing nations, thereby unlocking a wave of new employment opportunities and addressing critical social and economic challenges.

Moreover, the focus on energy education becomes paramount in this context. Equipping their populations with the necessary skills and knowledge is crucial for effectively deploying and managing of energy sector's development. By investing in energy-related education and vocational training, BRICS nations can empower their workforce to meet the demands of an evolving energy landscape. Additionally, fostering research and innovation in clean energy technologies will pave the way for ground-breaking advancements that benefit all member countries. As observed by the QS World University Rankings, BRICS universities accounted for 10% of the top 800 universities globally in 2016, marking a significant increase from 7% in 2009, which emphasizes the region's commitment to quality education.

BRICS is committed to fostering inclusive growth and addressing societal inequalities, particularly concerning women's empowerment in the energy sector. As part of their collective efforts, BRICS countries aim to create opportunities and initiatives that include the disadvantaged and marginalized populations, ensuring they actively participate and benefit from the energy industry's growth. With a focus on gender equality, BRICS nations promote policies and programs that support the advancement of women in the energy sector, advocating for equal access to education, training, and leadership positions. By striving for an inclusive and diverse energy workforce, BRICS seeks to tackle gender disparities and foster a more equitable and sustainable energy landscape.

Ultimately, the overarching goal of this cooperation extends beyond individual nation-building efforts. By aligning their energies and ambitions, the BRICS nations aspire to forge a global path towards sustainability. Their dedication to sustainable energy practices and shared knowledge exchange, in line with the United Nations' Sustainable Development Goals (SDGs) and the Paris Agreement, holds the potential to significantly contribute to international targets, driving the world towards a more sustainable and prosperous future.

This report addresses the existing state of energy skills within the BRICS countries and the challenges they face in ensuring energy skills development both in the present and for the future, especially concerning their energy transitions. It also emphasizes significant areas of collaboration in the context of energy skills. It is recognised that the BRICS countries have distinct energy strategies that complement each other, presenting opportunities for enhanced intra-BRICS cooperation in advancing energy skills to bolster domestic energy security and fuel economic growth.

CHAPTER 1

ENERGY TRANSITION SKILLS OF THE BRICS COUNTRIES

BRAZIL

[1.1]

1.1.1 CURRENT DEMOGRAPHICS

The Brazilian Institute of Geography and Statistics (IBGE) is responsible for collecting and disseminating the main demographic data in Brazil. According to the most recent information, the total population of the country is approximately 213.9 million people (2021), occupying an area of 8,510,345.538 km². Based on this data, we can conclude that Brazil is a country with a large population in absolute terms, placing it among the largest in the world, but with a low population density, with only 22.43 inhabitants per square kilometer.

The distribution of the population across the Brazilian territory is irregular. The most populous region is the Southeast, with 89,632,912 inhabitants, with about half of them residing in the state of São Paulo. On the other hand, the Midwest region is the least populated, with 16,707,336 inhabitants. In terms of federative units, Roraima is the least populous state, with an estimated 652,713 inhabitants in 2021.

In recent years, the country's population growth has slowed down, due to the gradual reduction in fertility and birth rates. The fertility rate, which was already higher than two children per woman in the mid-twentieth century, has remained stable at around 1.76 since at least the year 2000. Furthermore, infant mortality has declined in recent decades, reaching current rate of 11.56 per thousand live births.

Another important and more recent phenomenon is the aging of the Brazilian population. This is due to several factors, such as a reduction in the number of births, improvements in health, broader economic development indices and other aspects of everyday life that ensure life expectancy. Currently, life expectancy at birth in Brazil is 76.6 years (IBGE, 2020), being higher for women (79.9 years) than for men (73.1 years).

National Education System

Education in Brazil, according to what is determined by the Federal Constitution and the Law of Guidelines and Bases of National Education (LDB – 9.394/96), is the responsibility of the Union, states, Federal District and municipalities, which must manage and organize their respective education systems. Each of these public education systems is responsible for its own maintenance, which generates funds, as well as the mechanisms and sources of financial resources. The Brazilian educational system is divided into Basic Education and Higher Education. Basic Education, from the Law of Guidelines and Bases of Education (LDB - 9.394/96), started to be structured by stages and teaching modalities, encompassing Early Childhood Education, compulsory Elementary Education of nine years and High School.

Basic Education

Basic Education, from the Law of Guidelines and Bases of Education (LDB - 9.394/96), started to be structured by stages and teaching modalities, encompassing Early Childhood Education, compulsory Elementary Education of nine years and High School. It is mandatory and it is the duty of parents or guardians that children and young people complete basic education, just as it is the duty of the State to provide this education.

Modalities:

i. Early Childhood Education: duration of 4 years, with students from 0 to 3 years old;
ii. Pre-school: duration of 3 years, with students from 4 to 6 years old;
iii. Elementary School: duration of 9 years, with students from 6 to 14 years old;
iv. High School: duration of 3 years, with students from 15 to 17 years old;
v. Technical High School: schools can offer technical courses in non-shift periods, which are extra-class periods for their students. The duration is variable and can be from 1 to 3 years.

Other Modalities of Basic Education:

Special Education - Special Education exists to meet the demand of students with disabilities or mental illnesses. It is applicable in any type of educational institution that must meet technical demands in terms of material, technology and pedagogy. Even so, it is more common to find educational centers dedicated to this type of education.

This type of education is divided into three categories:

i. Dependent - is that aimed at students hospitalized in hospitals or clinics due to a state of disability, which prevents them from taking care of themselves or from attending environments without special guidance;
ii. Trainable - serves those students who have a type of need, but are fully capable of socializing without help;
iii. Educable - serves those students who have vocabulary capable of socialization and adaptation skills. These are students who acquire a disease in adulthood.

Special education still faces challenges in the inclusion of students in the school environment and in social interaction. For this reason, it is distinct from inclusive education, which seeks to adapt the environment to meet the needs of all students, regardless of their disabilities.

One of the main challenges of special education is related to pedagogical practice. Obstacles still exist to promote the necessary changes in the structure and functioning of the school in order to provide the necessary needs. In addition, teachers need to receive specific training aimed at assisting these students.

Basic Education Numbers

Elementary School Early years:

- 69.3% of basic education schools (123.6 thousand) offer some stage of fundamental education. Of these, 106,800 offer the initial years;
- There are almost two early-year schools for every final-year school: 61,800 schools offer the last stage of elementary school;
- With 10.1 million students, the municipal network has a 69.6% share of total enrollments in the initial years and concentrates 84.8% of students from the public network;
- In the early years, 18% of students attend private schools. The private network decreased by 7.1% between 2020 and 2021;
- 24.6% of establishments offering initial years have up to 50 students 1 and only 14.7% have more than 500;
- 98.9% of the population from 6 to 14 years old2 attend school: in the age group from 6 to 10 and from 11 to 14 years old, attendance is 98.6% and 99.3%, respectively.

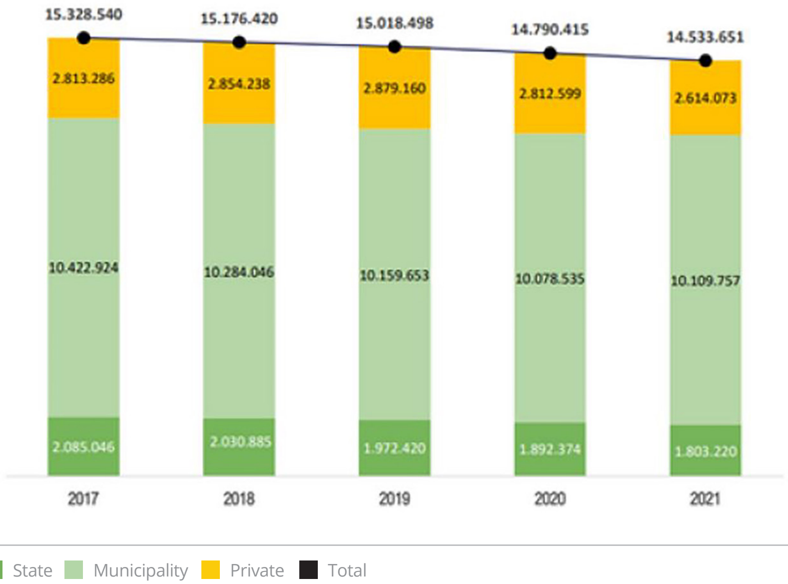


Figure 1: Evolution of Registrations in the Initial Years of Basic Education in Brazil from 2017-2021

Source: Inep/Scholar Census 2021

Elementary School Final Years:

- With 4.8 million students, the state network has a 40% share of total enrollment in the final years, sharing the responsibility of the public power in this stage of education with the municipalities, which have 5.3 million students (44.7%);
- In the final years, 15.0% of students attend private schools;
- 12 million students attend the final years of elementary school and 99.8% of these students attend the day shift;
- Elementary education is the largest stage of all basic education with 26.5 million students;

Federal State Municipality Private Total

Figure 2: Evolution of Registrations in the Final Years of Basic Education in Brazil from 2017-2021

Source: Inep/Scholar Census 2021

High School:

- 92.5% of the population aged 15 to 171 attend school;
- There were 7.77 million enrollments in secondary education in 2021, an increase of 2.9% in the last year. This growth establishes an upward trend in enrollments observed in the last two years (4.1% increase from 2019 to 2021);
- 84.4% of high school students study during the day shift;
- million (15.5%) students study at night;
- 94.6% of students attend urban schools;
- The private network, which has around 935,000 students, has a 12% share of high school enrollment;
- With 6.6 million students, the state network has a share of 84.5% of total enrollments and concentrates 96% of students from the public network. The federal network has a substantial participation in secondary education, 229 thousand students or 3% of the total;
- 44.1% of high schools serve more than 500 students.

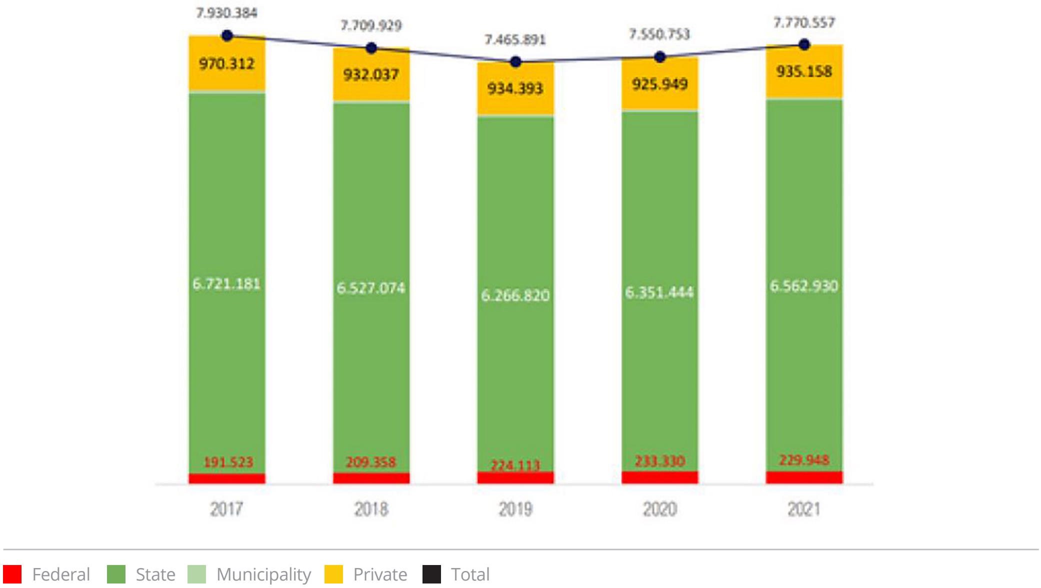


Figure 3: Evolution of Registrations in High School in Brazil from 2017-2021

Source: Inep/Scholar Census 2021

Table 1: Indicators on Education: Brazil versus OECD

Index	Rate	
	Brazil	OECD
Gains from schooling in the labour market		
Schooling rate of women aged 25 to 34 years in higher education	57.0%	57.0%
Schooling rate of women aged 55 to 64 years in higher education	59.0%	52.0%
Employment rate among 25 to 34 years with higher education degree (2020).	82.0%	83.0%
Ratio of relative earnings of workers aged 25 to 64 years with higher education degree in relation to those who have completed elementary school (2020)	394	205
Access and conclusion of the population in formal education		
Gross enrollment rate (GEF) in tertiary education in the five-year age group immediately after the theoretical upper secondary school leaving age (2020)	55.0%	76.0%
Average completion rate in higher education over technical course duration (N) (2020)	33.0%	39.0%
Average completion rate in tertiary education three years after the end of the theoretical duration (N+3) (2020)	49.0%	67.0%

Index	Rate	
	Brazil	**OECD**
Percentage of children who are enrolled in formal education one year before the official primary school entry age (2020)	93.0%	98.0%
Public spending on education		
Percentage of total public spending on education (2019)	14.0%	10.6%
Percentage of total public spending on higher education (2019)	3.6%	2.8%
Evolution of total public spending on education (elementary to higher education) between 2015 and 2019	-3.5%	8.0%
Evolution of total public spending between 2015 and 2019	1.0%	11.0%
Percentage of public funds for higher education coming from the central government	73.0%	88.0%
Profile and working conditions of docents		
Statutory starting salary of teachers in the final years of primary education (USD equivalent converted to PPP)	14 345	37 466
Percentage of higher education docents who are over 50 years old	30.9%	40.4%

Source: INEP-National Institute of Educational Studies and Research Anísio Teixeira

Professional and Technological Education – EPT

Professional and technological education in Brazil is supported by Law No. 9,394, of December 20, 1996, known as the Law of National Education Guidelines and Bases (LDB), and is regulated by Decree No. 5,154, of July 23, 2004. The General National Curriculum Guidelines for Professional and Technological Education are protected in the Resolution of the Full Council of the National Council of Education (CNE/CP) No. 1, of January 5, 2021.

According to article 39 of the LDB, professional and technological education covers different levels and types of courses, which are as follows: I - initial and continuing training courses or professional qualification; II - high school technical professional education courses; III - undergraduate and graduate technological professional education courses.

This type of teaching focuses on professional and technological qualification, providing students with the necessary knowledge in a specific profession. It is usually offered by technical schools that not only provide professional skills, but also promote behavioral and intellectual development to face the job market. Therefore, this type of education aims to enable students to compete in the job market, work and collaborate in a team, based on the pillars of knowing how to be, knowing how to live together, knowing how to do and knowing how to know.

It is common to find this teaching modality in institutions of the so-called "S System" (Senai, Senac, SEST, Sebrae...) and in the Federal Network of Professional, Scientific and Technological Education (Federal Institutes, Cefets, Colégio Pedro II and Technical Schools linked to universities federal), in addition to the State Professional Education Networks and in private schools. In the S System and in the Federal Network, courses are offered at different levels of professional qualification, covering technical training, higher education and postgraduate studies.

Initial and Continuing Education or Professional Qualification

As established by Decree No. 5,154, of July 23, 2004, and Resolution CNE/CP No. 1, of January 5, 2021, professional qualification courses (referred to as courses in item I of article 39 of the LDB) include several modalities, such as professional training, improvement, specialization, updating, apprenticeship and special programs with variable duration. These courses aim to develop skills for productive and social life. They can be articulated with youth and adult education courses (EJA), allowing, in this case, the professional qualification and the performance of the worker's education level, who, upon successful completion of these courses, receive training certificates for work.

These courses can be offered in training itineraries that favor the continuity of training and, in this case, must have a minimum workload of 160 hours for initial training, as established by article 3, paragraph 1 of Decree No. 5,154, of July 23 de 2004. It is up to the institutions and teaching networks responsible for offering these courses to structure and register the certificates issued.

Middle Level Technical Vocational Education

Secondary level technical professional education courses are defined in item II of article 39 of the LDB, as well as in item II of article 1 of Decree No. 5,154, of July 23, 2004.

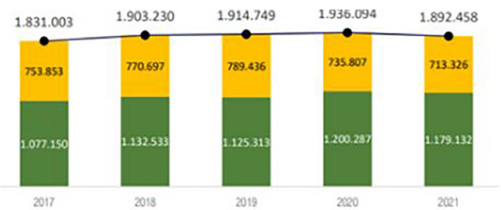
According to article 36-B of the LDB, secondary technical professional education can be developed in conjunction with secondary education, in courses with a single enrollment, or subsequently, in courses for people who have already completed education average. In addition, article 36-C establishes that the articulated form can be developed in an integrated way to secondary education, with a single enrollment, or concomitantly, with different enrollments.

CNE/CP Resolution No. 1, of January 5, 2021, determines in its article 15 that mid-level technical professional education covers: I - technical professional qualification, related to the technical course; II - technical professional qualification, as a stage with completion of a technical course;

III - technical professional specialization, from the perspective of continuing education. These courses are organized by technological axes, according to the National Catalog of Technical Courses (CNCT), as established by the same resolution in its 5th article.

The LDB, in its article 62, allows the training of teachers for the initial years of fundamental education to be promoted through teaching courses in the normal modality offered with secondary education. These courses, even providing professional training and being integrated into secondary education, are not clearly characterized as professional and technological education courses experienced in Chapter III of the same LDB.

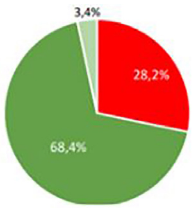
Evolution of enrollment in professional education* by teaching network – Brazil 2017-2021



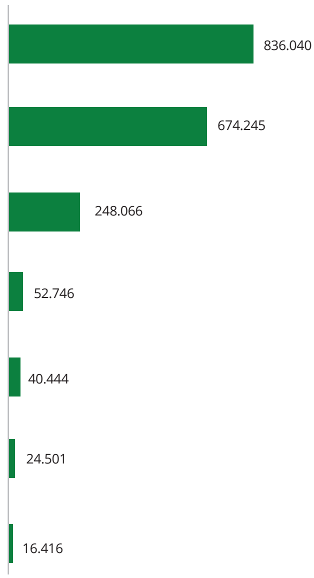
Public Private Total

Distribution of professional education enrollment* in the public school network by administrative dependency – Brazil 2021

Federal State Municipality



Distribution of professional education enrollment* by stage/type of education – Brazil 2021



*Include concurrent and subsequent technical course, integrated with regular high school, normal/teaching, integrated with EYA (fundamental and secondary levels) and IFO (fundamental, secondary and concomitant levels).

Figure 4: Distribution of Professional Education Enrolment (Source:Inep/Scholar Census 2021)
Source: Inep/Scholar Census 2021

Undergraduate Professional Technological Education

Undergraduate technological professional education courses are included in item III of article 39 of the LDB, as well as in item III of article 1 of Decree No. 5,154, of July 23, 2004.

According to CNE/CP Resolution No. 1, of January 5, 2021, entry-level technological education encompasses technological professional qualification, technological development and the higher technological education course, also known as the higher technology course (CST). However, enrollment data for technological professional qualification and technological development were not considered, due to lack of information in data sources.

Higher technology courses are initiation programs that offer specialized training in scientific and technological areas, training graduates with skills to work in specific professional fields, characterized by technological axes. These courses are organized in accordance with the guidelines protected in Resolution CNE/CP nº 1, of January 5, 2021, and are grouped into technological axes defined by the National Catalog of Higher Technology Courses (CNCST).

Graduate Technological Professional Education

Postgraduate technological professional education courses are complied with in item III of article 39 of the LDB, as well as in item III of article 1 of Decree No. 5,154, of July 23, 2004.

According to CNE/CP Resolution No. 1, of January 5, 2021, postgraduate technological professional education comprises professional specialization, professional master's degree and professional doctorate. However, in this work, the information referring to the professional specialization mentioned in the CNE Resolution was not considered, due to the lack of this data in the used information sources.

The offer of *stricto sensu* professional master's and professional doctoral programs is subject to the norms and recommendations of the Coordination for the Improvement of Higher Education Personnel (Capes), in accordance with the guidelines and opinions of the CNE.

Youth and Adult Education – EJA

Aimed at young people and adults who did not finish their studies at the appropriate age, whether in elementary or high school, the Youth and Adult Education (EJA) has increasingly focused on serving this category of students. One of the most used modalities for this is distance learning, allowing the interested party to access the content at their convenience, on various online platforms.

In addition to allowing the person to resume their studies, EJA also offers a shorter training time compared to regular education. To qualify for EJA, a student must meet certain criteria, such as being at least 15 years old to complete elementary school and 18 years old for high school. EJA students complete their studies and are fully qualified to enter higher education, under the same conditions as a regular student. To do so, they must dedicate themselves to their studies, which are normally offered in six-month modules, equivalent to a year of elementary school or a year of high school.

Indigenous People Education

As the name suggests, Indigenous People Education is aimed at the indigenous or original people population, respecting the culture, conditions and language of each community served. This modality represents a significant challenge for national institutions, especially the, now renamed, National Indigenous People Foundation (FUNAI), due to the ethnic diversity of the current indigenous population, which comprises 305 ethnic groups with 274 different languages.

In Indigenous People Education, it is necessary to produce bilingual teaching material (in the indigenous language and in Portuguese) to preserve each tradition and culture, in addition to offering professional training to teachers in a multicultural way. Infrastructure is another crucial challenge in this modality. According to the 2017 school census, 30.93% of indigenous schools do not have obedience, making it necessary to improvise classes in community spaces or borrowed by the community.

There is a priority in training indigenous professionals capable of applying education aimed at the indigenous population. As universities are encouraged by public notices, they can invest in training indigenous teachers. Education aimed at indigenous peoples requires that teaching materials meet the demands of each ethnic group, which represents another major challenge. Ideally, these materials should be produced by the indigenous population itself, ensuring that they are in line with the culture, history and traditions of each community.

Distance Education

One of the teaching modalities that has grown significantly in Brazil is distance education (EaD, from Portuguese), also called distance learning. This modality differs from traditional teaching in several aspects, either by the physical distance between student and teacher, or by the way in which the educational content is accessed. The internet has played a fundamental role as an audio modality, offering several media and platforms that guarantee a technical qualification and even a postgraduate degree for enrolled students.

Each educational institution has its own platform and teaching plan in the virtual environment. Another striking difference is the growing preparation of teachers for this type of approach in the educational system. The great advantage of EaD is the possibility of bringing students closer to courses that would be inaccessible due to geographical distance. In addition, the flexibility of schedules makes this type of teaching accessible to people with difficulties in reconciling studies with their daily schedule.

Distance education is widely found in higher education courses, but it is also possible to find versions in technical, professional courses and other categories, allowing the student to obtain a certificate recognized by the Ministry of Education (MEC). For this, the educational institution needs to comply with the rules protected by the Law of Guidelines and Bases of Education (LDB) and submit a series of documents to the MEC.

It is still possible to find face-to-face courses that incorporate modules with distance classes, combining or even replacing classes in a physical classroom. Even when the course is completely distance learning, the student can participate in moments of interaction with professors and others. course colleagues, whether in face-to-face activities or through virtual environments.

College Education

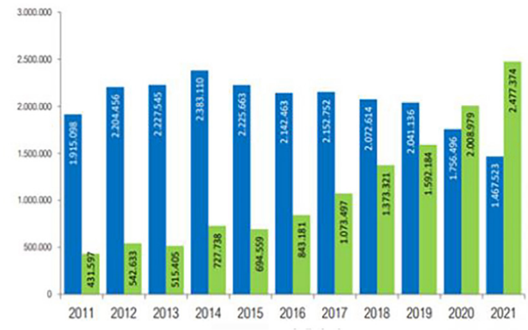
According to the 2021 Higher Education Census, released by the National Institute of Educational Studies and Research Anísio Teixeira (Inep), the number of students entering distance education (EaD) grew significantly in 2021. Compared to the previous year, there was a 23.3% increase in the number of new students enrolled in distance learning courses offered by public and private higher education institutions (HEIs), while enrollments in face-to-face courses fell by 16.5%.

When we analyze only private colleges, which offer most places, the increase in calories in the virtual modality was 24.4%. With this advance, the total number of students enrolled in EaD courses reached the mark of 3.5 million, surpassing the 3.3 million students enrolled in face-to-face courses. This is the first time this has happened on the private network.

Census data reveal that Brazil ended last year with almost 9 million enrollments distributed in 2,574 higher education institutions. Of the total number of enrollments, 6.9 million (76.8%) were in the private network.

When we look only at the number of new entrants, six out of ten new higher education students (62.8%) opt for EaD courses. If we consider only enrollment in private education, the preference rate is even higher, with seven out of ten students opting for this type of education.

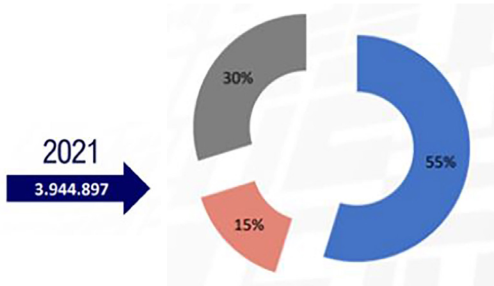
Number of students entering graduation courses – Brazil 2011-2021



Presencial Distance learning

Source: MEC (Ministry of Education)/Inep: Higher Education Census

Distribution of freshmen by academic degree of the course – Brazil 2021



Note: The values of entrants from basic areas of entry are not computed.

Bachelor degree Licentiate degree Technician

Source: MEC (Ministry of Education)/Inep: Higher Education Census

The number of enrollments in graduate distance courses has increased substantially in recent years. On the other hand, the number of entrants in face-to-face courses has been decreasing since 2014, having the lowest value registered in 2021 in the historical series of the last 10 years. The licentiate degree recorded a drop of -12.8% between 2020 and 2021.

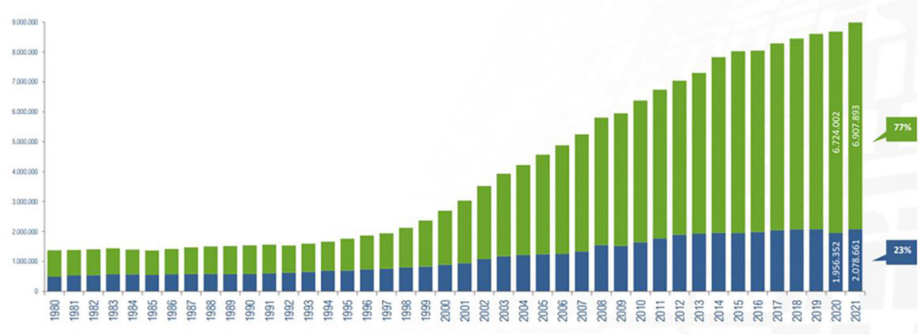
Figure 5: Brazil's Number of Students Entering Graduation Courses from 2011-2021

The data reveal the growth of private education and the increase in access by Brazilians to higher education in general. In the last decade, there was a 32.8% increase in the percentage of students enrolled in higher education, with an average annual growth of 2.9%.

However, this increase is not driven by the face-to-face modality, which registered a drop of 23.4% between 2011 and 2021. The protagonist of this growth is the Distance Learning modality, which had a 474% increase in the number of students in the last decade especially driven by the effects of the pandemic.

The development of new teaching methodologies, the expansion of the offer in several regions of the country (with more than 35 thousand centers installed) and the wide coverage of higher education institutions are factors that obeyed the growth of the EaD modality. Also, the more affordable tuition, which can be 80% cheaper than a face-to-face course, is a significant advantage. There are Degree courses from R$ 99.00 per month and initial values of R$ 150.00 for Administration Fee, for example.

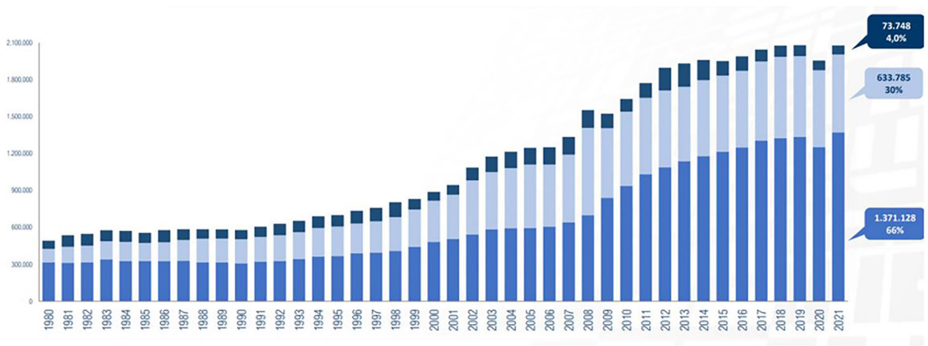
Other factors that drive the advancement of EaD are the good performance of Enade courses, the use of new technologies and the ever-increasing and natural presence of digital culture in society.



Public Private

With more than 6.9 million students, the private network continues to grow, between 2020 and 2021 it increased by 3%. In the public network, the increase in the number of enrollments returns, registering 6% between 2020 and 2021.

Figure 6: Number of Enrolments in Graduation Courses in Brazil from 1980 to 2021

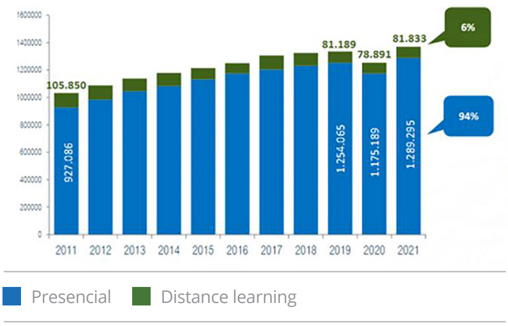


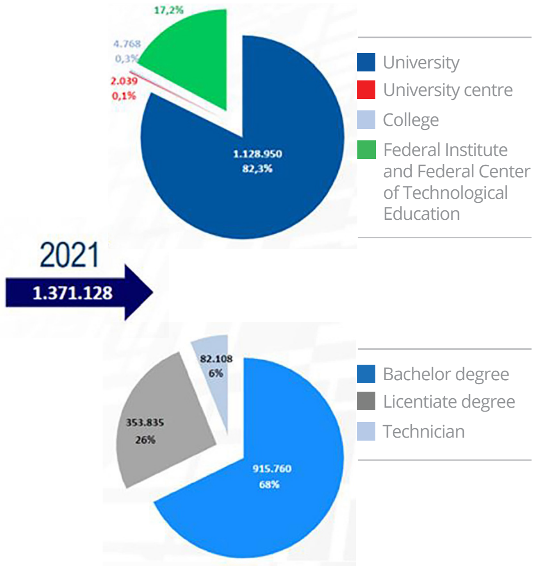
Federal State Municipality

In the last 10 years, the federal network increased the number of enrollments by 32.7% (2.9% p.y.). In the same period, the state network grew 2.3% and the municipal network had a reduction of 39.1%. Between 2020 and 2021, there was a positive variation of 9.3% in the federal network and 1.6% in the state network. In the municipal network there was a decrease of -6.1%.

Figure 7: Number of Enrolments in Graduation Courses in the Public Network in Brazil from 1980 to 2021

Evolution of the number of enrollments in the federal network, by type of education Brazil 2011-2021





The federal network has 68 universities and 41 federal institutes/federal centres of technological education. There are also 9 colleges, one linked to ME (INES) and 8 linked to other bodies (ENCE, ITA, IME, ISCP, EsEFEc, CIAvEx, ESslog, ESA), in addition to 1 university center (AMAN).

Figure 8: Evolution of the Number of Enrolments in the Federal Network in 2021

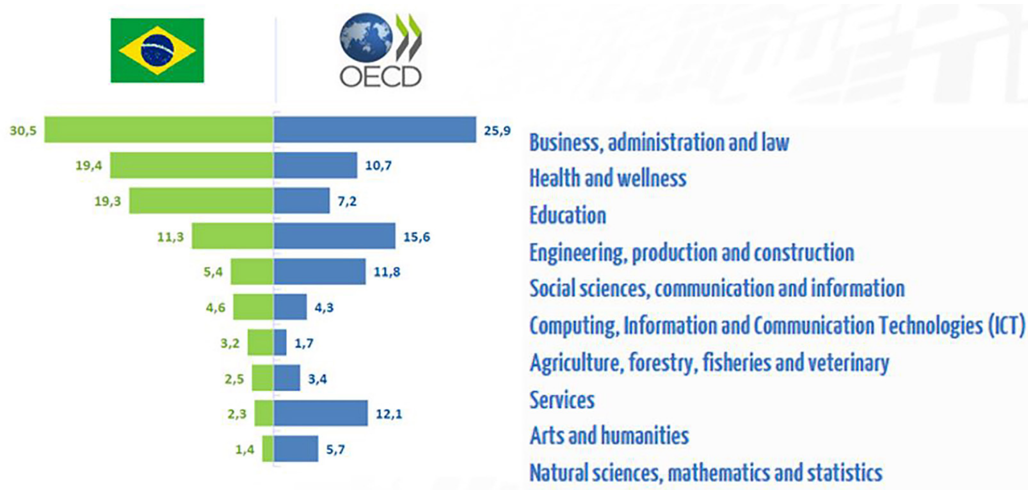


Figure 9: Graduate Enrolment Percentage Distribution by General Area for 2021

Source: MEC/Inep: Higher Education Census – Education at a Glance (OCDE)

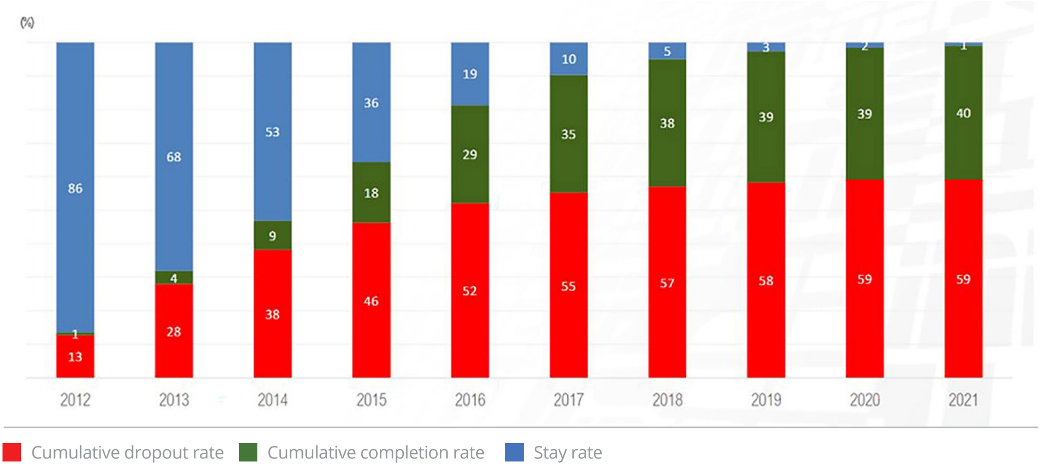


Figure 10: Evolution of the Trajectory Indicators of Students in the Admission Course from 2012 to 2021

Source: MEC/Inep: Higher Education Census

Ranking of Higher Education Institutions

There are different publications that produce classification rankings of Brazilian universities. Some of the main rankings used are:

- Ranking Universitário Folha (RUF): Produced by the newspaper Folha de São Paulo, it is one of the best-known rankings in Brazil. It considers indicators such as teaching quality, scientific research, internationalization, labour market and innovation.
- QS Ranking: Prepared by the British consultancy Quacquarelli Symonds (QS), it is one of the most prestigious international rankings. It evaluates a variety of criteria, including academic support, support among employers, citations in research, and evaluation of international faculty and students.
- Webometrics Ranking: Created by the Cybermetrics Lab, a research group from the Higher Council for Scientific Research in Spain, it is focused on the presence and impact of educational institutions on the web, considering factors such as visibility, transparency and research impact.
- THE Ranking (Times Higher Education): Published by the Times Higher Education magazine, it is one of the most recognized internationally. It takes into account indicators such as teaching, research, citations in scientific publications, internationalization and knowledge transfer.

- SCImago Ranking: Based on bibliometric indicators, the SCImago ranking evaluates the performance of institutions in terms of scientific research, international collaborations, impact and innovation.
- IGC (General Course Index) of INEP: It is a metric for evaluating the quality of higher education institutions in Brazil, created and disseminated by INEP (National Institute of Educational Studies and Research Anísio Teixeira). The IGC takes into account different indicators, such as the average of the Preliminary Course Concepts (CPC) of undergraduate courses and the result of the National Student Performance Examination (ENADE). The purpose of the IGC is to provide an overview of the quality of institutions, allowing a comparison between them. The IGC is used as a reference to classify institutions into different ranges, ranging from 1 to 5, with 5 being the highest score.

It is important to note that each ranking uses different methodologies to evaluate higher education institutions, and no ranking is perfect. Each has its own weightings and criteria, which can lead to variations in results.

INEP (National Institute of Educational Studies and Research Anísio Teixeira) is a federal agency linked to the Ministry of Education (MEC) of Brazil. He is responsible for producing and coordinating studies, research and educational estimates at all levels of education, from basic education to higher education. INEP plays a fundamental role in the collection and analysis of educational data, providing relevant information for the development and improvement of public educational policies in the country, and, in this way, we will present the IGC Ranking as the official one for the regulation processes of higher institutions.

Table 2: IGC Ranking of Brazil's Higher Institutions

	University	IGC (Continuous)	IGC (Range)
1	SCHOOL OF SOCIAL SCIENCES (FGV CPDOC)	4,943	5
2	BRAZILIAN SCHOOL OF ECONOMICS AND FINANCE (FGV - EPGE)	4,868	5
3	SÃO PAULO SCHOOL OF ECONOMICS (EESP)	4,781	5
4	CAMPINAS STATE UNIVERSITY (UNICAMP)	4,476	205
5	FACULDADE FUCAPE	4.455	5
6	MILITARY INSTITUTE OF ENGINEERING (IME)	4,450	5
7	BRAZILIAN SCHOOL OF PUBLIC AND BUSINESS ADMINISTRATION (EBAPE)	4,442	5
8	JESUIT FACULTY OF PHILOSOPHY AND THEOLOGY (FAJE)	4,431	5
9	FACULTIES EST	4,424	5

	University	IGC (Continuous)	IGC (Range)
10	AERONAUTICS TECHNOLOGICAL INSTITUTE (ITA)	4,400	5
11	SÃO PAULO LAW SCHOOL (FGV DIREITO SP)	4,383	5
12	FEDERAL UNIVERSITY OF MINAS GERAIS (UFMG)	4,368	5
13	FEDERAL UNIVERSITY OF RIO GRANDE DO SUL (UFRGS)	4,349	5
14	VITÓRIA LAW FACULTY (FDV)	4,280	5
15	NATIONAL INSTITUTE OF HIGHER EDUCATION AND POST-GRADUATION PADRE GERVÁSIO (INAPÓS)	4,280	5
16	FUNDAÇÃO UNIVERSIDADE FEDERAL DO ABC (UFABC)	4.211	5
17	FEDERAL UNIVERSITY OF SANTA CATARINA (UFSC)	4,197	5
18	FEDERAL UNIVERSITY OF SÃO PAULO (UNIFESP)	4,188	5
19	FACULDADE MULTIVIX SAO MATEUS	4.177	5
20	FACULDADE MULTIVIX DE CACHOEIRO	4.164	5
21	JÚLIO DE MESQUITA FILHO STATE UNIVERSITY OF PAULISTA (UNESP)	4.161	5
22	FACULDADE MULTIVIX CARIACICA	4.156	5
23	FACULTY OF THEOLOGY OF SÃO PAULO OF THE INDEPENDENT PRESBYTERIAN CHURCH OF BRAZIL	4.145	5
24	UNITED FACULTY OF VITÓRIA	4,140	5
25	FEDERAL UNIVERSITY OF RIO DE JANEIRO (UFRJ)	4.138	5
26	FEDERAL UNIVERSITY OF VIÇOSA (UFV)	4.116	5
27	RIO DE JANEIRO LAW SCHOOL (RIVER LAW)	4.116	5
28	FACULDADE SÃO LEOPOLDO MANDIC	4.108	5
29	FEDERAL UNIVERSITY OF SÃO CARLOS (UFSCAR)	4.081	5
30	COLLEGE OF BALSAS (UNIBALSAS)	4.076	5
31	FEDERAL UNIVERSITY OF LAVRAS (UFLA)	4.062	5
32	FEDERAL UNIVERSITY OF SOUTH BAHIA (UFSB)	4,060	5
33	FACULDADE CESAR (FCE)	4.047	5
34	SÃO PAULO SCHOOL OF BUSINESS ADMINISTRATION (FGV EAESP)	4.045	5
35	FACULDADE FIPECAFI	4.024	5
36	FEDERAL UNIVERSITY OF PARANÁ (UFPR)	4.023	5
37	FEDERAL UNIVERSITY OF HEALTH SCIENCES FOUNDATION OF PORTO ALEGRE (UFCSPA)	4.011	5
38	FACULTY OF MEDICAL SCIENCES OF SANTA CASA SÃO PAULO (FCMSCSP)	4.007	5
39	CATHOLIC FACULTY OF RIO GRANDE DO NORTE	3,990	5
40	UNIVERSITY OF BRASILIA (UNB)	3,988	5

	University	IGC (Continuous)	IGC (Range)
41	FACULDADE ARI DE SÁ (FAS)	3,985	5
42	CHRISTIAN COLLEGE OF CURITIBA (FCC)	3,977	5
43	FACULDADE DE CASTELO - MULTIVIX CASTELO	3,969	5
44	SCHOOL OF MEDICINE OF SÃO JOSÉ DO RIO PRETO (FAMERP)	3,962	5
45	FACULDADE ESCOLA PAULISTA DE LAW (FACEPD)	3,961	5
46	SAINT PAUL FACULTY OF TECHNOLOGY	3,950	5
47	UNIVERSIDADE ESTADUAL DO NORTE FLUMINENSE DARCY RIBEIRO (UENF)	3,933	4
48	FEDERAL UNIVERSITY OF SANTA MARIA (UFSM)	3,928	4
49	FEDERAL UNIVERSITY OF BAHIA (UFBA)	3.925	4
50	BRAZILIAN UNIVERSITY CENTER (UNIBRA)	3.925	4

*Universities that do not participate in Enade, such as USP, are not included in the ranking.
** Data consulted on 09/05/2023.

We also present the Folha University Ranking (RUF):

Table 3: RUF Ranking of Brazil's Higher Institutions

	Name	Public/private	State	Note
1	UNIVERSITY OF SAO PAULO	STATE	SP	98.02
2	CAMPINAS STATE UNIVERSITY	STATE	SP	97.09
3	FEDERAL UNIVERSITY OF RIO DE JANEIRO	FEDERAL	RJ	97.00
4	FEDERAL UNIVERSITY OF MINAS GERAIS	FEDERAL	MG	96.72
5	FEDERAL UNIVERSITY OF RIO GRANDE DO SUL	FEDERAL	RS	95.68
6	UNIVERSIDADE ESTADUAL PAULISTA JÚLIO DE MESQUITA FILHO	STATE	SP	92.67
7	FEDERAL UNIVERSITY OF SANTA CATARINA	FEDERAL	SC	92.58
8	FEDERAL UNIVERSITY OF PARANÁ	FEDERAL	PR	92.02
9	UNIVERSITY OF BRASILIA	FEDERAL	DF	91.21
10	FEDERAL UNIVERSITY OF PERNAMBUCO	FEDERAL	PE	89.77
11	FEDERAL UNIVERSITY OF CEARA	FEDERAL	CE	89.47
12	FEDERAL UNIVERSITY OF SÃO CARLOS	FEDERAL	SP	89.15
13	UNIVERSITY OF THE STATE OF RIO DE JANEIRO	STATE	RJ	87.81
14	FEDERAL UNIVERSITY OF BAHIA	FEDERAL	BA	86.95

	Name	Public/private	State	Note
15	FEDERAL UNIVERSITY OF VIÇOSA	FEDERAL	MG	86.84
16	FEDERAL UNIVERSITY OF SÃO PAULO	FEDERAL	SP	86.73
17	FEDERAL FLUMINENSE UNIVERSITY	FEDERAL	RJ	86.66
18	PONTIFICAL CATHOLIC UNIVERSITY OF RIO GRANDE DO SUL	PRIVATE	RS	84.31
19	PONTIFICAL CATHOLIC UNIVERSITY OF RIO DE JANEIRO	PRIVATE	RJ	83.68
20	GOIAS FEDERAL UNIVERSITY	FEDERAL	GO	83.58
21	FEDERAL UNIVERSITY OF SANTA MARIA	FEDERAL	SC	83.16
22	FEDERAL UNIVERSITY OF RIO GRANDE DO NORTE	FEDERAL	RN	82.57
23	STATE UNIVERSITY OF LONDRINA	STATE	PR	82.12
24	MARINGÁ STATE UNIVERSITY	STATE	PR	81.48
25	FEDERAL UNIVERSITY OF UBERLÂNDIA	FEDERAL	MG	79.65
26	JUIZ DE FORA FEDERAL UNIVERSITY	FEDERAL	MG	79.31
27	FEDERAL UNIVERSITY OF ESPIRITO SANTO	FEDERAL	ES	78.67
28	FEDERAL UNIVERSITY OF LAVRAS	FEDERAL	MG	78.4
29	FEDERAL UNIVERSITY OF PARÁ	FEDERAL	PA	78.11
30	PONTIFICAL CATHOLIC UNIVERSITY OF PARANÁ	PRIVATE	PR	76.88
31	FEDERAL UNIVERSITY OF PARAIBA	FEDERAL	PB	76.55
32	FEDERAL UNIVERSITY OF PELOTAS	FEDERAL	RS	75.13
33	FEDERAL UNIVERSITY OF MATO GROSSO	FEDERAL	MT	73.95
34	MACKENZIE PRESBITERIAN UNIVERSITY	PRIVATE	SP	73.6
35	FEDERAL RURAL UNIVERSITY OF RIO DE JANEIRO	FEDERAL	RJ	72.83
36	UNIVERSITY OF VALE DO RIO DOS SINOS	PRIVATE	RS	71.61
37	FEDERAL UNIVERSITY OF SERGIPE	FEDERAL	SE	70.26
38	FUNDAÇÃO UNIVERSIDADE FEDERAL DO ABC	FEDERAL	SP	70.2
39	FEDERAL UNIVERSITY OF OURO PRETO	FEDERAL	MG	69.96
40	SANTA CATARINA STATE UNIVERSITY FOUNDATION	STATE	SC	69.37
41	FEDERAL UNIVERSITY OF MATO GROSSO DO SUL	FEDERAL	MS	67.49
42	UNIVERSITY OF CAXIAS DO SUL	PRIVATE	RS	67.43
43	UNIVERSIDADE ESTADUAL DO NORTE FLUMINENSE DARCY RIBEIRO	STATE	RJ	66.96
44	FEDERAL UNIVERSITY OF CAMPINA GRANDE	FEDERAL	PB	66.79

	Name	Public/private	State	Note
45	FEDERAL UNIVERSITY OF ALAGOAS	FEDERAL	AL	65.99
46	UNIVERSIDADE FEDERAL DO TRIÂNGLO MINEIRO	FEDERAL	MG	65.13
47	FEDERAL TECHNOLOGICAL UNIVERSITY OF PARANÁ	FEDERAL	PR	65.03
48	PONTA GROSSA STATE UNIVERSITY	STATE	PR	64.91
49	PONTIFICAL CATHOLIC UNIVERSITY OF MINAS GERAIS	PRIVATE	MG	64.33
50	FEDERAL UNIVERSITY OF SÃO JOÃO DEL REI	FEDERAL	MG	63.83

Education Numbers by Type of Energy

In this item of the report, focus will be on thematic areas which covers renewable energies and energy efficiency. Therefore, it comprehends hydraulic, solar photovoltaic, wind, biogas and biomethane, biofuel, renewable hydrogen, biomass, as well as energy efficiency in industry and buildings, electric mobility and energy storage. Bear in mind that such courses include technical, technological, undergraduate, and graduate courses offered by the entire range of institutions considered in the item “Brazilian educational system”.

In this way, the description below lists courses offered and their figures in the different professional training networks. These courses are regulated by the Ministry of Education and its Education Councils (national, state, district and municipal), depending on the features of the training offered. They can also be regulated by federal educational institutions and other organizations, considering the peculiarities of each professional offer and legal authorizations.

Initial and Continuing Training Courses (FIC)/ Professional Qualification

The Initial and Continuing Training (FIC) or professional qualification courses follow a Pronatec Guide of FIC Courses, having great autonomy for their creations and offerings by all professional training networks, however, to be financed by the Pronatec Program - National Access Program to Technical Education and Employment, must follow the professional profiles and workloads established in the more than 650 established courses. Initial and continuing education (FIC) or professional qualification are organized to prepare for productive and social life, promoting the insertion and reintegration of young people and workers in the world of work. This includes courses for professional training, improvement, and professional updating of workers at all levels of education. It includes special courses, freely offered, open to the community, in addition to professional qualification courses integrated into the training itineraries of the educational system.

Special Courses

As provided for in Art. 42 of the Law of Guidelines and Bases of National Education (LDB), initial and continuing education or professional qualification can be offered as special courses, open to the community, with their enrolment conditioned to the ability to take advantage of the training, and not necessarily to the education level. Such courses do not have a pre-established workload and can present different characteristics in terms of preparation for the professional practice of some basic occupations in the world of work or related to the personal exercise of activities that generate work and income.

Free Courses

As provided for in Art. 42 of the Law of Guidelines and Bases of National Education (LDB), initial and continuing education or professional qualification can be offered as free courses, open to the community, with their enrolment conditioned to the ability to take advantage of the training, and not necessarily to the education level. Such courses do not have a pre-established workload and can present different characteristics in terms of preparation for the professional practice of some basic occupations in the world of work or related to the personal exercise of activities that generate work and income.

Regular Courses

When organized by the educational system within a training itinerary in order to enable continuity of studies, initial and continuing training courses (FIC) or professional qualification have regulations regarding the workload. The minimum duration of 160 hours is established in § 1 of Art. 3 of Decree No. 5154/2004, amended by Decree No. 8268/2014.

The professional profile for completing the FIC or professional qualification courses must correspond to the profiles necessary for the exercise of one or more occupations with an identity recognized by the labour market. They must guarantee professionalization in a particular area and, at the same time, the continuous and articulated use of studies at different levels of national education. It is possible to find out about some training paths in the guidelines set out in the National Catalog of Technical Courses.

Professional Qualification, including initial and Continuing Training for Workers

It is worth noting that initial and continuing education (FIC) or professional qualification, as it is called in the LDB, is also called “professional qualification, including initial and continuing training for workers”, determined in Decree No. 8,268/2014.

Offering Institutions

- The institutions that comprise:
- The federal, state, district and municipal networks of professional and technological education;
- National Learning Services (SNAs);
- Private institutions of professional and technological education;
- Schools qualified to offer courses in the National Program for Access to Technical Education and Employment (Pronatec).

In addition to the institutions listed above, special courses can be offered by companies, class associations, unions, churches, etc.

Certificates

Completion of initial and continuing training courses (FIC) or professional qualification entitles you to a certificate that gives the holder proof of the development of knowledge associated with a particular work function.

The institution offering the course is responsible for issuing the certificates, which serve as proof of the training received by the holder.

National Catalog of Technical Courses

The National Catalog of Technical Courses (CNCT) was approved by the National Council of Education (CNE) through Resolution CNE/CEB nº 2, on December 15, 2020, and provides guidance and information for educational institutions, students, companies and society in general. The catalog content is regularly updated by the Ministry of Education to meet new social and educational demands. For educational institutions, the Catalog serves as a reference for planning courses, advises professionals and technical specializations of the corresponding mid-level. For students, the Catalog provides essential information when choosing their courses, presenting different professional profiles, possibilities for work and other relevant details.

In the productive sector, the Catalog assists in hiring professionals with the skills best suited to the needs of companies.

The Catalog is organized into thirteen technological axes, which represent organized and systematized sets of knowledge, skills and abilities from different areas (scientific, legal, political, social, happiness, organizational, cultural, ethical, aesthetic, etc.).

Each axis grouped specific courses, providing information such as minimum workload, expected professional profile, necessary infrastructure, field of activity, occupations associated with the Brazilian Classification of Occupations (CBO), standards related to professional practice and certification options promoted in professional qualification courses, continuing education in specialization courses and progression to undergraduate courses.

In addition, the Catalog also includes a list of courses that had their names changed over time (convergence table), with previous and current names, as well as a list of courses whose inclusion in the Catalog was denied (submission table).

Students, workers, employers, educational institutions and other bodies related to professional practice can access information about the courses offered in the Catalog through the National Information System for Professional and Technological Education (SISTEC).

The fourth edition of the National Catalog of Technical Courses presents an electronic and interactive version, which allows a quick and direct search for information. In addition to updating professional profiles, this edition expands information related to CBO, prerequisites for entering courses and includes a list of specific terms used in Professional and Technological Education, with the aim of disseminating and clarifying these words.

In this way, the Catalog is not only a normative document, but also a source of information for students, entrepreneurs, educational institutions, and society in general. The transition to the new edition of the National Catalog of Technical Courses establishes that educational institutions will have a period of up to two years, counting from the publication of Resolution CNE/CEB nº 2 of 2020, for their course offerings and to update the Projects Pedagogical of the Courses according to the new edition of the CNCT.

National Catalog of Higher Technology Courses

The National Catalog of Higher Technology Courses (CNST) is a specific normative reference to support the planning of higher-level professional technological education courses, also called Technologists' Courses or Higher Technology Courses. The documents list the denominations and respective descriptors of higher technology courses. The objective is to consolidate such denominations and establish a framework capable of guiding the administrative processes of regulation and the policies and procedures for evaluating these courses.

In this way, the catalog is a guiding instrument for students, higher education institutions, education systems and the general public. They also contribute to providing greater visibility and public and social recognition of these graduations.

The 3rd and current edition of the CNST was approved by Ordinance MEC nº 413, of May 11, 2016, and coordinated by the Secretariat for Regulation and Supervision of Higher Education (Seres) in collaboration with the Secretariat for Professional and Technological Education (Setec), both from the Ministry of Education. It is undergoing a review and update that should be completed in 2023.

Content

The 3rd edition of the CNST brings in its structure 134 denominations of Higher Technology Courses, grouped into 13 technological axes, with the following description by course:

- Completion professional profile;
- Minimum required infrastructure;
- Minimum workload;
- Acting field;
- Associated CBO occupations;
- Possibilities of continuing studies in post-graduation lato sensu and stricto sensu.

In addition, the 3rd edition of the CNST contains, in an annex, the Convergence Table, containing the correspondence between the names of technical courses that are no longer in use and those present in the catalog.

How are the Education Numbers for Energy Types Presented

To present the numbers of Brazilian education for the types of energy, it is necessary to understand the dynamics of the offer of professional courses in Brazil, presented previously. Some databases allow us to make the connection that was established at the beginning of this item, in its first paragraph, where it is understood that there are several levels and formations that can qualify, train and certify professionals for the different types of energies.

Technical, Technologies/Graduation Courses in Renewable Energy and Energy Efficiency

- **Technical courses in:** Agriculture; Agroecology; Agriculture; aquaculture; Industrial automation; Biofuels; Buildings; Electricity and Aeronautical Instruments; Electronics; Electromechanics; Electronics; Electrotechnical; Mechanical Manufacturing; Industrial instrumentation; Maintenance of Industrial Machines; Maintenance of Naval Machinery; Heavy Machinery Maintenance; Maintenance of Metro Rail Systems; Mechanics; Mechatronics; Mining; Refrigeration and Air Conditioning; and Renewable Energy Systems.

- **Higher technology courses in:** Agroecology; Agribusiness; Foods; Industrial automation; Beneficiation of ores; Biofuels; Construction of Buildings; Industrial Electronics; Industrial Electrotechnics; Renewable energy; Exploitation Mineral Resources; Mechanical Manufacturing; Irrigation and Drainage; Aircraft Maintenance; Industrial maintenance; Industrial Mechatronics; Mining; Oil and Gas; Food Production; Industrial production; Refrigeration and Air Conditioning; and Electrical Systems.

- **Undergraduate engineering courses:** Agricultural; Architecture; Construction; of Control and Automation; power; of Oil and Gas; of Electric Production; Electric; Industrial; Mechanics; and Mechatronics.

All these courses have, to a greater or lesser extent, disciplines and curricular units, with different workloads, that deal with renewable energies and energy efficiency, allowing the professional to work in different profiles and professional skills for renewable energies and energy efficiency discussed above.

Federal Network of Professional, Scientific and Technological Education

The Federal Network of Professional, Scientific and Technological Education is a set of public education institutions in Brazil, linked to the Ministry of Education. This network is made up of federal institutes of education, science and technology, federal centres of technological education, technical schools linked to federal universities, in addition to other technical and technological education units. The main mission of the Federal Network is to offer quality education, integrating professional training with scientific and technological development, aiming to train competent professionals who are prepared to meet the demands of the labour market and promote the socioeconomic development of the country.

All academic information on this Federal Network can be obtained from the **Nilo Peçanha Platform - PNP**, already described, and which allows the filters for identification proposed here: education numbers for types of energy.

Note: The National Apprenticeship Systems (SNAs) and the state networks of professional education, as well as the private schools, follow the same dynamics as the federal network, offering professional education at the levels of professional qualification and mid-level technicians. However, as they do not have an easily accessible database, we cannot present their numbers in a stratified manner. We can understand from the INEP Censuses that the other networks represent four-fifths of these professional education offers.

Universities

The National Curriculum References for the Bachelor's and Licentiate's Courses make up one of the actions that tune higher education to social and economic demands, systematizing names and descriptions, identifying effective higher education courses in Brazil. The Universidade 360° Platform is a knowledge tool aimed at higher education, which offers access to integrated data and academic, budgetary and personnel management indicators of federal universities.

Its intuitive interface has interactive maps, responsive diagrams, tables and other visual resources that prioritize the quality of the user experience. Through this platform, citizens, the press and managers have the possibility to search for information on general data on higher education in Brazil.

The main objective is to establish a social observatory focused on transparency and governance of federal universities, seeking to improve the precision of decisions and reduce the response time of public policies. The platform is based on analytical management solutions and an integrated approach to academic indicators, budget execution and staff development in the federal education network.

In addition, it offers resources to interpret and identify behaviours, patterns and trends, providing support for proactive management strategies. In addition to all this, it will serve as a basis for technical, scientific and planning studies aimed at strengthening and improving public policies. The platform is aimed at the entire civil society, managers of federal universities, the Ministry of Education, the academic and school community, control bodies of the executive, legislative and judicial powers, as well as press agencies.

1.1.2 LABOUR MARKET ANALYSIS IN THE ENERGY SECTOR

Wind Energy

With 890 wind farms installed in 12 Brazilian states, the country has an installed capacity of 25.04 gigawatts (GW) of wind energy in commercial operation, which benefit more than 100 million people. The Northeast region is home to 85% of these parks.

The Brazilian Association of Wind Energy (ABEEólica) predicts that by 2028 the country will have 44.78 GW of installed capacity, increasing the share of wind energy in the energy matrix to 13.2%. Wind already accounts for 20% of the energy generated in Brazil.

In 2022, the sector broke a record with 4 GW installed, and the expectation is to surpass that number this year. By the end of 2023, the forecast is that the installed capacity will reach 29 GW. Taking into account the new investments contracted, wind generation capacity should increase by around 50% over the next five years. This projection may prove to be even more optimistic, given that wind energy generation costs are already competitive in relation to other sources. In addition, the domestic regulation of offshore wind farms in 2022 will secure the sector taking advantage of the available wind generation potential on land and at sea.

It is estimated that onshore production had a potential of over 500 GW, while offshore production has a potential of just over 1,200 GW, according to a World Bank study. It is worth mentioning that the total electricity generation capacity in Brazil is already at 190 GW, considering all energy sources.

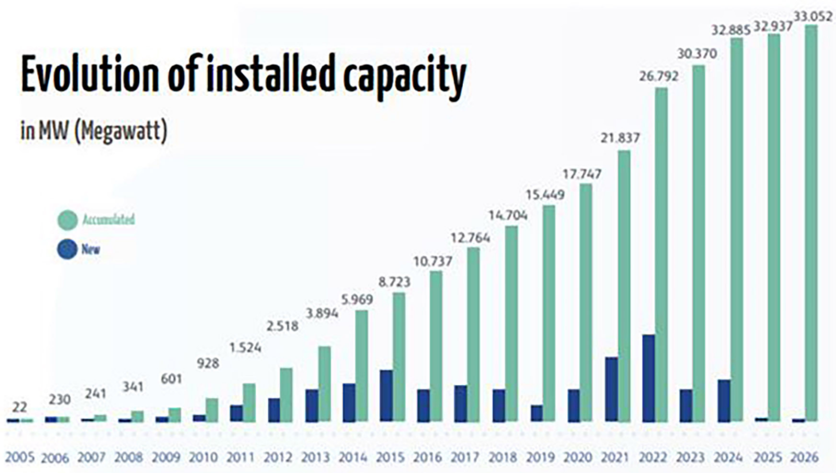


Figure 11: Evolution of Brazil's Installed Capacity

Areas of Expertise

The wind sector in Brazil has shown significant growth in recent years, mainly driven by the policy to encourage renewable energies and favorable natural resources, such as strong winds and extensive coastal areas. The expansion of the wind sector has contributed to the creation of jobs in different areas, from the manufacture and installation of wind turbines to the operation and maintenance of wind farms.

Some of the areas that can benefit from job creation in the wind sector include:

i. **Wind turbine manufacturing and installation:** Companies involved in the production and assembly of wind turbines can create jobs in the production line, engineering, logistics and installation of turbines in wind farms.

ii. **Development of wind farms:** The development of wind farms requires professionals in several areas, such as engineering, geology, environment, project management, law and consulting.

iii. **Operation and maintenance of wind farms:** Once the wind farms are in operation, qualified personnel are required to monitor and operate the wind turbines, as well as to carry out preventive and corrective maintenance.

iv. **Specialized Technical Services:** Companies specializing in technical services such as data analysis, remote monitoring, wind forecasting and wind farm optimization can provide specialized jobs in the sector.

v. **Research and development:** Technological innovation in the wind sector can generate job opportunities in research and development of new wind technologies, more efficient materials and energy storage solutions.

In addition, the growth of the wind sector can also boost the creation of indirect jobs in areas such as transport, civil construction, supply of equipment and consulting services.

Jobs Generation

To estimate direct jobs, use the start-up schedule of new wind turbines, their average power and a job technician per average power, already adjusted for scale gains. Indirect/induced commands were estimated using the same command multiplier applied to GDP. In the case of Opex, the creation of jobs was made by applying the added value to this activity together with the added value of maintenance activities, inspired by the installation of machinery and equipment, in addition to the electricity, natural gas and other sectors. This percentage of added value was then applied to the total occupations of these two activities, generated in the values mentioned in the table below. Finally, it is estimated that electricity generated from wind sources currently supports around 155,000 occupations, based on an "Okun's law" that relates total GDP and the level of employment. Taking into account only the direct and indirect/induced effects associated with CAPEX, a ratio of 10.7 jobs per installed MW is estimated, with 4.4 direct jobs and 6.3 indirect/induced jobs.

Taking into account only the direct and indirect/induced effects associated with CAPEX, we estimate a ratio of 10.7 jobs per MW installed (4.4 direct and 6.3 indirect/induced). In the case of OPEX, this ratio is 0.6 jobs per installed MW (2020).

Table 4: Estimated Impacts of the Wind Sector on the Brazilian Occupation Level

	Jobs associated with CAPEX			Jobs associated with OPEX	Jobs associated with the value added (GDP) of electricity from wind sources	Total
	Direct	indirect/induced	Total			
2011	9.4	13.5	22.9	0.9	7.8	31.6
2012	9.4	13.5	22.9	1.4	12.3	36.6
2013	8.9	12.9	21.8	2.1	12.3	36.6
2014	8.4	12.1	20.5	3.2	19.1	42.8
2015	8.1	11.7	19.9	5.0	50.4	75.3
2016	7.9	11.4	19.3	6.2	86.1	111.7
2017	7.7	11.1	18.9	7.3	113.4	139.5
2018	7.3	10.5	17.7	8.3	132.9	159.0
2019	7.0	10.1	17.2	8.7	154.1	180.0
2020	5.9	8.5	14.4	10.2	155.2	179.8

According to the study “CREATION OF JOBS IN THE BRAZILIAN WIND SECTOR: Estimates in the short, medium and long term”, by Cognitio Consultoria/GIZ, the wind sector has a predominantly technical employment profile, with different skills in each stage of the value chain. About 60% of jobs in the sector require a high school education, reflecting the importance of vocational technical education in the workforce. In addition, there is a significant portion of professionals with higher education, especially engineers. The participation of women in the sector is approximately 20% and this number is expected to grow, with a ratio of 3 women for every 10 jobs in the sector.

According to the survey, 10.08 jobs/year/MW will be generated along the entire wind value chain. These jobs changed based on the volume of wind power added and are related to wind farm development, manufacturing, construction and installation activities. In addition, the creation of jobs in the operation and maintenance (O&M) segment increases over time, according to the accumulated load.

However, this standard will face challenges in the medium and long term due to ongoing technological advances and possible variations in the degree of nationalization. In terms of technological advances, it will be necessary to assess the limits of growth in the size of wind turbines due to logistical issues related to the installation of wind farms on land.

Photovoltaic Solar

Solar energy in Brazil is experiencing rapid growth, driven by therapeutic and environmental effects. Representing 13.1% of the electrical matrix, it is the second largest source of energy in the country, second only to hydroelectric power. The number of installed photovoltaic systems has increased, especially in the South and Southeast regions. Solar energy is widely used in homes to reduce the electricity bill, either by heating water or generating electricity.

Brazil has an enormous potential for solar energy, with solar incidence levels higher than countries such as Germany, France and Spain. It is essential to widely explore photovoltaic generation in the country, taking advantage of its natural stimuli. It is estimated that by 2024 there will be around 887,000 solar energy systems connected to the grid, bringing savings and environmental preservation. Thanks to the efforts of the government and the private sector, Brazil is getting closer and closer to realizing its full potential and becoming a powerhouse in the photovoltaic energy market. The sector has already generated more than 868,800 jobs between 2012 and 2023, according to ABSOLAR. São Paulo is the state with the highest installed capacity of distributed photovoltaic generation, followed by Minas Gerais and Rio Grande do Sul.

Currently, there are 1,890,095 photovoltaic systems connected to the grid in the country, generated in an installed capacity of 20,417.0 MW and placing Brazil in the 8th position in the world ranking in 2022.

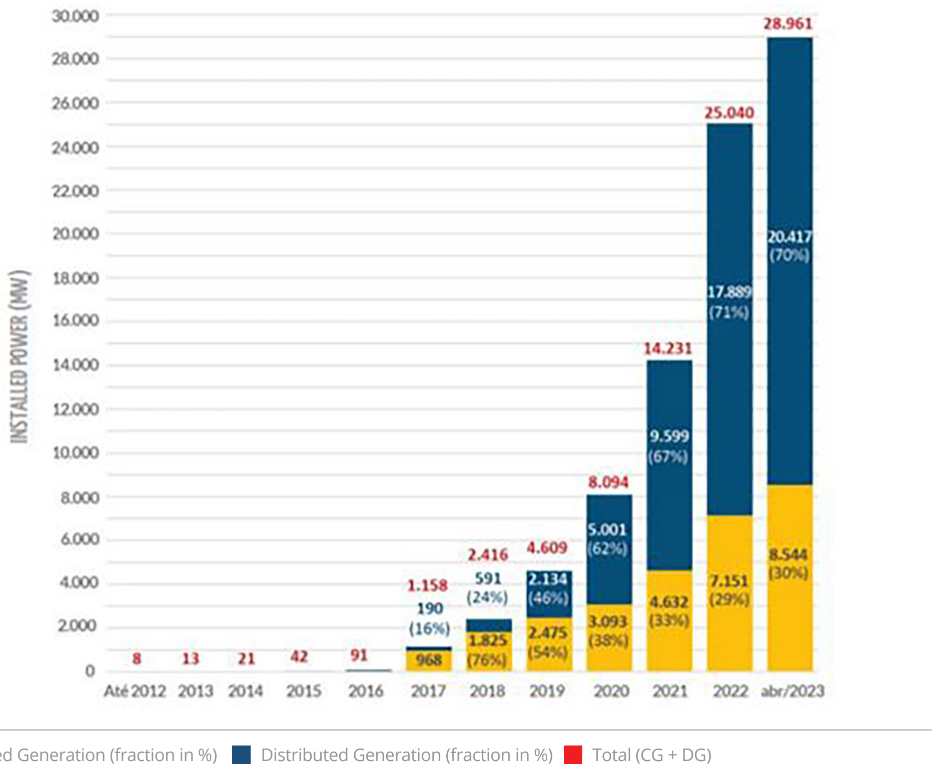


Figure 12: Evolution of Photovoltaic Solar Source in Brazil

Source: ANEEL/ABSOLAR, 2023

Areas of Expertise

A photovoltaic solar energy professional can work in several areas related to the development, implementation and maintenance of photovoltaic systems. Some of the main areas of activity are:

i. **Design and Engineering:** Professionals design photovoltaic systems, analyze technical and economic feasibility, size system components and prepare installation plans.

ii. **Installation and Assembly:** Responsible for the physical installation of solar panels, inverters and other system components, ensuring correct electrical connection and integration with the existing electrical grid.

ii. **Operation and Maintenance (O&M):** Professionals carry out preventive and corrective maintenance of photovoltaic systems, monitor performance, identify and resolve faults or operating problems, ensuring the efficiency and durability of equipment.

iv. **Sales and Consulting:** Professionals work in the sale of photovoltaic systems, visiting customers, presenting commercial proposals, offering advice on the benefits and financial return of solar energy, and assisting customers in their decision-making.

v. **Research and Development:** Professionals dedicated to research and innovation in the field of photovoltaic solar energy, seeking to improve the efficiency of solar panels, develop new technologies and solutions, and contribute to the advancement of the industry.

In addition to these specific areas, solar energy professionals can also work in related areas such as energy legislation and regulation, financing and investment in solar projects, education and technical training, among others. The demand for protected professionals in this sector has increased significantly due to the growth of photovoltaic solar energy.

Jobs Generation

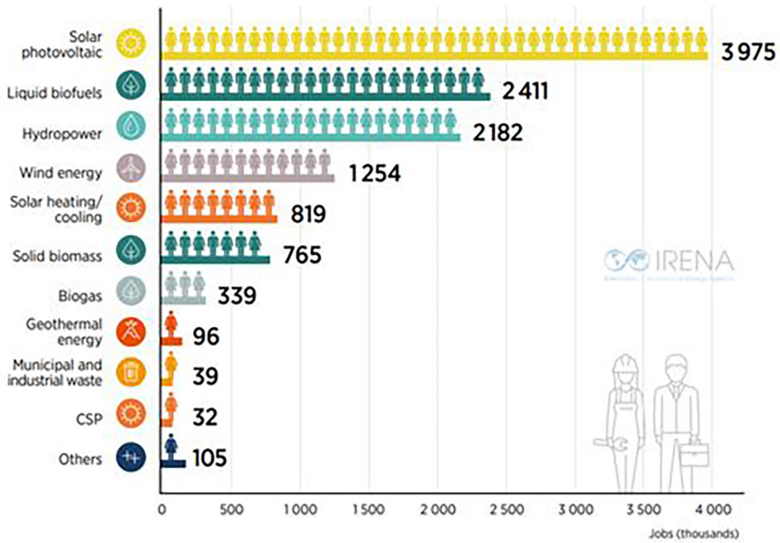
Since 2012, the solar energy sector in Brazil has been responsible for creating over 750,000 jobs across all regions of the country, including 330,000 in the last year alone. According to the chairman of ABSOLAR's board of directors, these hires demonstrate the constant growth of the sector, and the perspectives indicate that by the end of 2023 more than 1 million jobs will be generated since 2012, covering all productive areas and regions of the country. country.

Accumulated investments in the solar sector since 2012 should exceed the R$ 170.9 billion mark by December of this year, with public tax collection estimated at R$ 53.8 billion. Currently, investments have already reached more than R$ 125 billion, confident with more than R$ 39 billion in tax collection for the country. In addition, solar energy has played a significant role in reducing carbon dioxide emissions, preventing the release of more than 33.4 million tons of this gas into the Brazilian atmosphere over the last 11 years.

According to ABSOLAR projections, photovoltaic solar energy should generate more than 300 million additional jobs in 2023, consolidating itself as a source of promising investments, which should exceed the R$ 50 billion mark. This information was disclosed at the ABSOLAR National Meeting, an annual event held in December 2022 for the Brazilian solar sector.

For the next year, the addition of 10 gigawatts (GW) of installed power is expected, bringing the accumulated total to more than 34 GW. This growth represents an increase of more than 52% in relation to the current capacity of solar energy in Brazil. Of the total 34 GW, 21.6 GW will come from small and medium-sized systems installed by consumers in homes, small businesses, rural properties and public buildings, while the other 12.4 GW will be generated by large solar plants.

The CEO of ABSOLAR highlights that solar energy is one of the most competitive renewable sources in the country and plays a fundamental role in social, economic and environmental development. He points out that solar energy promotes the generation of jobs and income, attracts investment, diversifies the electrical matrix and offers systemic benefits to all citizens. He concludes by stating that Brazil has much to gain from this source of energy and is anxious to become an increasingly strategic world leader in this sector. IRENA proves that the Solar Photovoltaic sector is the renewable sector that generates the most jobs.



Note: CSP = Concentrated solar power. "Others" include tide, wave and ocean energy, and jobs not broken down by individual renewable energy technologies.

Figure 13: Jobs Generated Through Brazil's Renewable Energy Sources

Source: IRENA Jobs database

Hydrogen

Brazil has the conditions to become a major exporter of low-carbon hydrogen. The country has abundant natural resources, such as wind, solar and water energy, in addition to a large resource of biomass, which allow the generation of electricity in a sustainable way. Currently, hydrogen production in Brazil is concentrated in the refining and fertilizer (ammonia) industries, using processes with high CO2 emissions.

The Brazilian government aims at decarbonizing hydrogen production, by promoting all low-carbon hydrogen technological routes. From renewables, residuals and nuclear to fossil fuels with carbon capture, utilization and storage (CCUS) or pyrolysis and geological hydrogen (also called natural hydrogen). This transition strategy aims to reduce carbon emissions in the energy sector, particularly in hard to abate sectors.

Hydrogen will play an important role in energy transition and decarbonization of the world economy, including by providing more alternatives to energy storage.

Areas of Expertise

The hydrogen professional can work in several areas related to this energy source. Some of the main areas of activity are:

i. **Research and Development:** Professionals can engage in research and development of hydrogen-related technologies, including the production, storage, transportation, and use of hydrogen as a fuel.

ii. **Hydrogen Engineering:** Engineers specializing in hydrogen can design, build, and operate hydrogen production, storage, and distribution systems.

iii. **Renewable Energy:** Hydrogen is often considered a form of energy storage for renewable energy such as solar, wind, and biomass. Professionals can work on the development and integration of renewable energy systems with the production and use of hydrogen.

iv. **Sustainable Mobility:** Hydrogen is a promising alternative to fossil fuels for mobility. Professionals can be involved in the development of hydrogen-powered vehicles, fueling stations and related infrastructure.

v. **Industrial Applications:** Hydrogen has several applications in industry, such as use as a shielding gas, fuel for industrial processes and raw material to produce ammonia and methanol. Professionals can work on the development and optimization of industrial processes involving hydrogen.

vi. **Consultancy and Advice:** Professionals specialized in hydrogen can offer consultancy and technical assistance to companies, governments and organizations interested in adopting hydrogen technologies.

These are just a few of the areas of expertise for hydrogen professionals, and the field is constantly evolving as more research is conducted and new applications are discovered.

Jobs Generation

The hydrogen industry in Brazil is concentrated on carbon intensive technological routs (mostly in refineries and fertilizers), while low carbon technological routs are still R&DI projects. However, several high-scale projects have been announced in the last couple of years (one is under construction and the others are under feasibility studies. Thus, the number of people directly employed in this industry is expected to change over time. Furthermore, it is important to point out that hydrogen has the potential to protect job creation in different areas such as engineering, research and development, manufacturing, operation and maintenance of hydrogen-related equipment, as well as in environmental, humans and social sciences, law, communications, IT, data science, among others.

As the hydrogen industry expands, it is expected that the number of professionals involved will also increase. In addition, it is important to consider that hydrogen can have applications in several sectors, such as energy, transport, industry and buildings, which further expands job opportunities in this area.

Biogas, Biomethane and Biofuels

Biogas is an energy resource obtained through the anaerobic digestion of organic waste from the sugar-energy industry (such as straw, bagasse, vinasse and filter cake), the animal protein chain (animal waste, slaughterhouse and dairy waste), agriculture (such as soybean hulls, corn and waste from the cassava industry) and sanitation (solid urban waste and effluent treatment plants).

Once produced, biogas can be used for various purposes, such as heat generation, electricity generation (working like a natural gas thermoelectric plant, but 100% renewable and continuous, without continuous) or, after going through a purification process, can be transformed into biomethane, a gaseous biofuel composed mainly of methane, equivalent to fossil natural gas.

Considering Brazil's global commitment to reducing methane emissions, the energy crisis the country faces, the growing dependence on imported fuels and fertilizers, biogas can be part of the short- and medium-term solutions for the decarbonization of sectors - key to the Brazilian economy.

The Brazilian Association of Biogas (ABIOGÁS), which has the participation of 125 companies in the biogas value chain, has as its main objective to work for the insertion, consolidation and sustainability of this strategic energy source in the Brazilian energy matrix. Its focus is on institutions responsible for formulating policies, regulating and developing the sector's market.

Areas of Expertise

A biogas and biomethane professional has several areas of expertise, depending on their skills, specializations and interests. Here are some of the main areas these professionals can work in:

i. **Project development:** Biogas and biomethane professionals can work in the development of projects related to the production, storage and use of these gases. This includes identifying adequate biomass sources, designing production systems and sizing infrastructure for the collection and treatment of organic waste.

ii. **Engineering and design:** These professionals can work in the field of engineering and design of biogas and biomethane production systems. They can design and optimize anaerobic digestion units, biogas purification systems for biomethane production, storage and transport systems, among others.

iii. **Operation and maintenance:** Once the biogas and biomethane systems are in operation, constant monitoring is required to ensure their optimal performance. Professionals in this field can be involved in the operation and maintenance of systems, monitoring gas production, troubleshooting, performing preventive maintenance and ensuring compliance with regulations and safety standards.

iv. **Research and development:** Research and development of new technologies and processes related to biogas and biomethane are areas in which professionals can specialize. This involves investigating new sources of biomass, improving production and purification processes, improving energy efficiency and reducing environmental impacts.

v. **Project management and consulting:** Professionals with skills in project management and consulting can help coordinate projects related to biogas and biomethane. They can manage teams, handle regulatory issues, conduct economic and environmental feasibility assessments, and provide expert advice to companies and organizations.

vi. **Education and awareness:** Biogas and biomethane professionals can also play an important role in educating and raising awareness about these forms of renewable energy. They can provide training, participate in events and outreach campaigns, and provide technical information to the general public, with a view to promoting the sustainable use of biogas and biomethane.

These are just some of the areas of expertise available to biogas and biomethane professionals. The field is constantly evolving and offers opportunities for diverse profiles and specializations.

Jobs Generation

A survey was carried out to assess the impacts of biogas on employability and production along the value chain in the states of Paraná, Rio Grande do Sul and Santa Catarina, located in the southern region of Brazil. The biogas under analysis is generated from inputs from livestock, agribusiness, urban solid waste (MSW) and treated sewage.

The study was carried out in four distinct stages: 1) establishment of a baseline; 2) consideration of scenarios with greater demand, growth in supply and full use of substrates available in the South region; 3) awareness of these scenarios; and 4) differentiation of direct, indirect and induced effects.

In the three states, we estimate that the Gross Production Value (GPV) of biogas is USD 85 million, with an Attributed Value (AV) generated of 13.86 million. This production results in 3,494 direct jobs, which could reach 7,261 when we consider the direct, indirect and induced effects. It was found that the generation of jobs through biogas in Brazil is greater than the generation of jobs in traditional energy sectors, such as oil and gas production, and hydroelectric plants. In a scenario of increased demand and maximum use of capacity, the total number of jobs generated could reach 8,840, considering direct, indirect and induced workers. If there was investment to double the existing capacity, the number of direct jobs could reach 33,255 direct, indirect and induced workers.

Finally, if all the substrate available in the three states were used to generate biogas, up to 283,637 people would be employed, including direct, indirect and induced effects. Starting from this study, it is possible to make an assumption that between the maximum and minimum margins of use of the substrates, there are the capacities of job generation for the other cities and regions of Brazil, being able to say that the average is in 1.7 jobs per Terajoule (TJ). Higher than that of the oil, gas, hydroelectricity and wind power generation sectors, whose ratios are 0.05, 0.12 and 0.2 jobs per TJ, respectively.

Energy Efficiency

Energy efficiency (EE) has been recognized as valuable to society and the economy, and its effects on job creation are being increasingly recognized in energy policies in many countries. In Brazil, however, studies of EE impacts have historically been limited to energy saved and investments avoided, with little attention paid to the jobs generated by these investments. Recently, the Ministry of Mines and Energy supported a study in the project so-called Energy System of the Future, under the German-Brazilian Cooperation, by means of GIZ, which estimated that the gross job creation will increase from 25 thousand in 2016 to 62 thousand in 2030 direct Jobs in energy efficiency activities, in full-time equivalent jobs (GIZ, MME and MEC, 2019). Figures are greater when indirect and induced effects are considered, as it will be displayed as follows.

Faced with the growing role of EE in medium-term expansion plans and in the Brazilian goals protected in the Paris Agreement, it is essential to understand and quantify the generation of jobs in this sector, as well as train and train human resources to work in this area.

Areas of Expertise

A professional who works with energy efficiency can work in several areas. Some of the main areas of activity include:

i. **Energy Audit:** Carry out inspections and expectations of energy systems and processes in buildings, industries or companies to identify opportunities for energy savings and efficiency improvements.

ii. **Energy Management:** Develop and implement energy management strategies and policies in organizations, monitoring and controlling energy consumption, identifying areas of waste and proposing measures to reduce costs and optimize energy use.

iii. **Energy Efficiency Project and Consultancy:** Develop projects and technical solutions to improve energy efficiency in lighting, air conditioning, thermal insulation, equipment and industrial processes, using cutting-edge technologies and practices.

iv. **Renewable Energies:** Work with the implementation, dimensioning, installation and maintenance of renewable energy systems, such as photovoltaic solar panels, solar heating systems, wind turbines, among others.

v. **Energy Certification:** Carry out energy estimates and certifications in buildings, following specific standards and criteria, to determine their energy performance and identify opportunities for improvement.

vi. **Education and Training:** Act in the qualification and training of professionals, companies and communities on energy efficiency, promoting awareness and dissemination of good practices.

vii. **Research and Development:** Carry out studies and scientific research to advance knowledge and application of energy efficiency technologies and strategies, confident for the development of innovative solutions.

These are just some of the areas of action, and it is important to emphasize that energy efficiency covers several sectors, such as buildings, turbines, transport, agriculture, among others. Therefore, career opportunities in energy efficiency are wide and diverse, with the possibility of working in both the public and private sectors, in companies, consultancies, research institutions, government agencies, among others.

The study launched in 2019, entitled "Potential jobs generated in the area of Energy Efficiency in Brazil from 2018 to 2030", in a partnership between GIZ and the MME and the MEC, as mentioned before, obtained the results described below in figures.

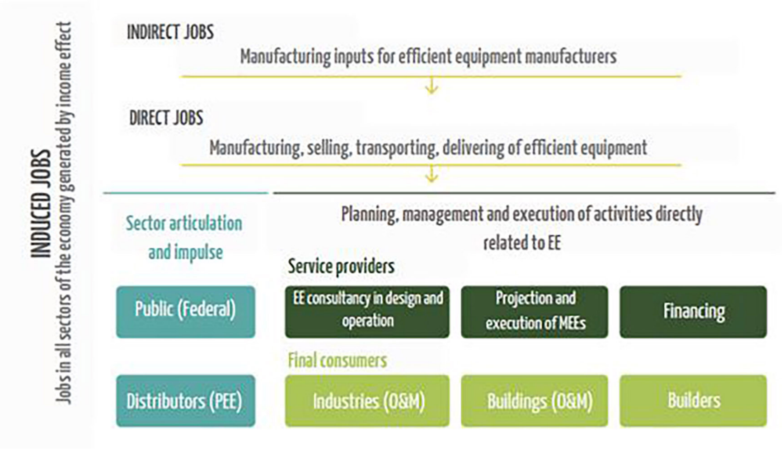


Figure 14: Induced Jobs in All Sectors of Brazil's Economy

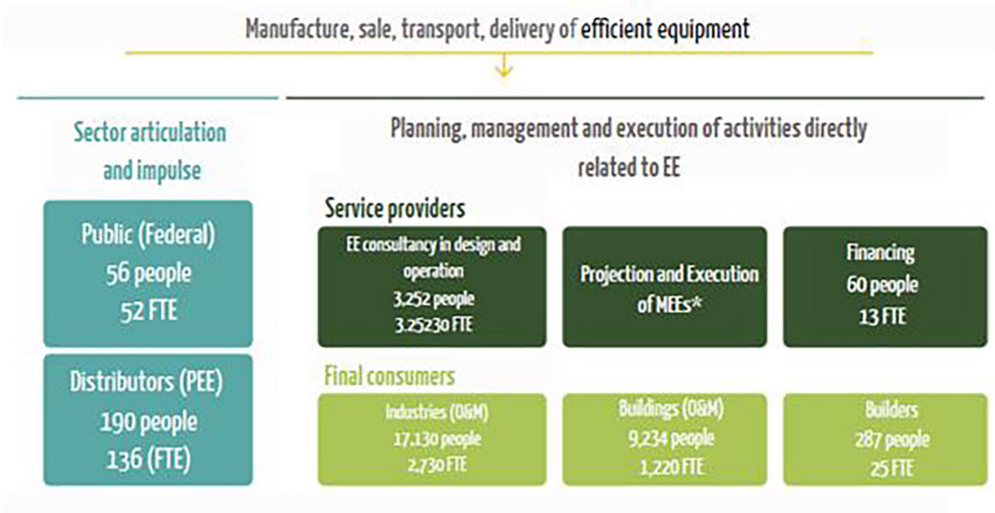
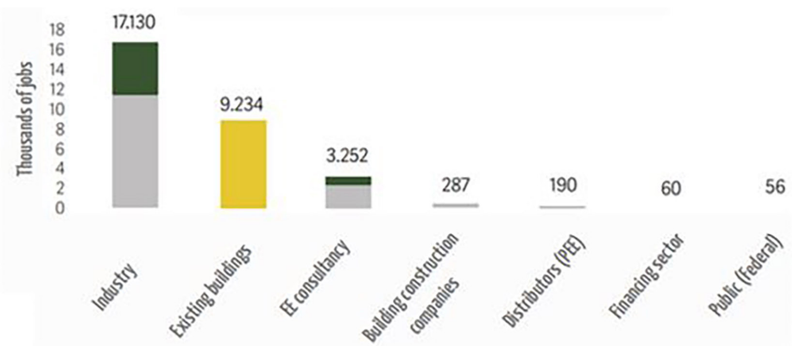


Figure 15: Number of Current Jobs Surveyed by the Bottom-Up Method



Higher level Technical level Unknown

Figure 16: Graph of the Results of the Current Survey of Direct Jobs in Energy Efficiency Activities and Projects Indicating the Total Number of People Employed

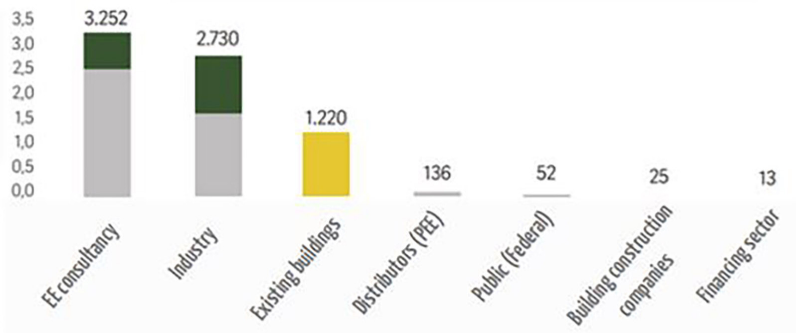


Figure 17: Graph of Results of the Current Survey of Direct Jobs in Energy Efficiency Activities and Projects Including FTE

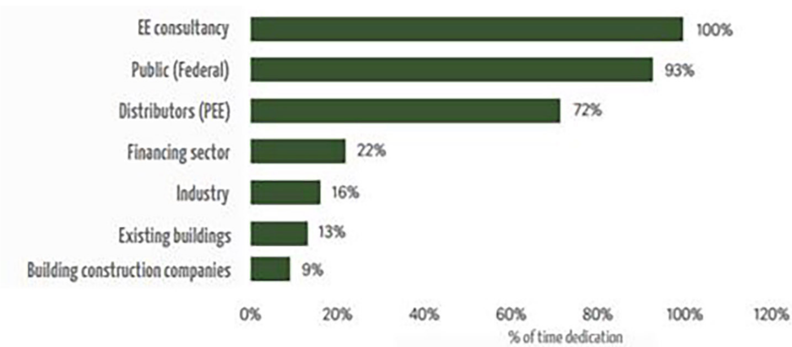


Figure 18: Average Dedication in Energy Efficiency of Jobs Surveyed by Sector

Jobs Generation

The demand for training in energy efficiency (EE) in Brazil is estimated at between 30 and 60 thousand professionals, corresponding to 11 thousand full-time equivalent (FTE) jobs. The greatest training opportunities are in the industrial and building sectors, with at least 25% of these opportunities being completed higher education.

However, the impacts of EE on job creation go beyond direct jobs in EE projects. It also includes 122 thousand FTE in companies involved in the manufacture, transport and sale of efficient products, in addition to 237 thousand FTE generated by indirect effects and 48 thousand FTE by induced effects.

The current amount of employment in EE activities and projects is below what is needed to achieve the targets protected in the Nationally Determined Contribution (NDC). To achieve these goals, Brazil should have had 27,000 FTE in EE activities and projects in 2018, however, it has only 11,000, which is more like the level 2 scenario that required 12,000 FTE in 2018. This indicates the need to expand incentives and programs to accelerate the demand, hiring and training of EE professionals in order to comply with NDC goals.

If Brazil currently has between 130 and 140 thousand direct jobs (FTE) in the EE sector, 11 thousand of which in specific activities of planning and executing EE projects, it will be necessary to have 450 thousand direct jobs (FTE) by 2030 to comply with the Brazilian NDC. Of these, 62,000 jobs must be trained in the planning and execution of EE activities. This implies a demand for professionals served in EE that could increase 5 to 6 times in the next 12 years in relation to current levels. Taking jobs across the economy into account, the trend is for demand to triple between 2016 and 2030 to reach an NDC. Therefore, effective policies to promote EE towards NDC have a high job creation potential.

It is important to emphasize that the number of people responsible for managing EE programs at the national level is very small compared to the number of employees involved in the execution of these projects (between 1 and 2.5%). This data serves as a starting point for discussions on the need to increase the number of people involved in the creation, direction and promotion of EE strategies in the country.

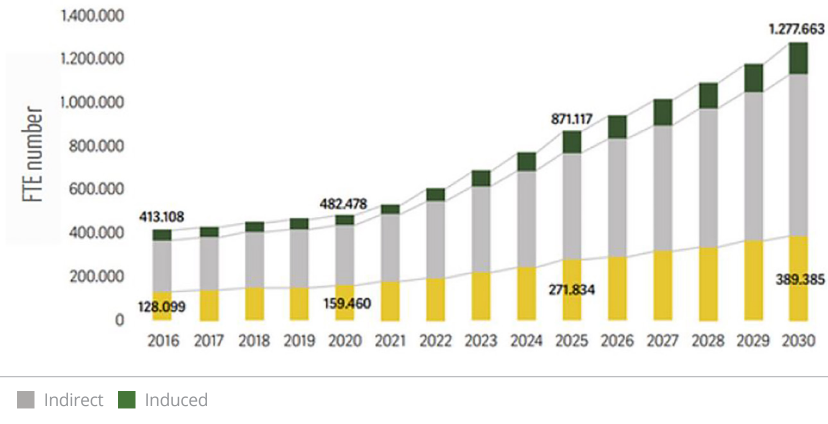


Figure 19: Generation of Gross Jobs for the Production of Energy Efficiency Goods and Services (Scenario Level 3)

Table 5: Employment Equivalent (FTE) Results of Current Energy Efficiency Existing

Section	Classification of jobs	Compiled result (number of FTE)
Public (Federal)	Direct jobs	52
Distributors (PEE)*		136
Industries (O&M)		2.730
Buildings (O&M)		1.220
Builders		25
Energy Efficiency Consulting in Design and Operation		6.405
Design and Execution of MEEs		
Financing		115
Manufacture, sale, transport, delivery of efficient equipment		121.579
Input manufacturing for efficient equipment manufacturers	Indirect jobs	236.717
Other sectors of the economy	**Induced jobs**	**48.291**

* Jobs within electricity distribution companies, involved in the management and execution of ANEEL's Energy Efficiency Program (PEE). Source: proper estimative.

1.1.3 PLANNING HORIZON FOR NATIONAL DEVELOPMENT

National development is a broad objective that aims to improve the quality of life of citizens, promote economic and social growth with inclusion, reduce inequalities and promote sustainability. In the case of Brazil, this could involve several areas, including:

- **Economy:** Pursuing sustainable economic growth, with emphasis on economic diversification, encouraging entrepreneurship and innovation, encouraging investment, job creation and macroeconomic stability.
- **Infrastructure:** Invest in improving the country's infrastructure, such as transport, energy, basic sanitation, telecommunications and technology. This could involve building new roads, ports, airports, expanding the power grid and improving digital connectivity.
- **Education:** Prioritize quality education, from early childhood education to higher education. Invest in educational infrastructure, teacher training, access to education for all citizens, improving curricula and promoting research and innovation. There is a stronger effort to expand technical and technological training through federal, state and private professional education networks.

- **Health:** Strengthen the health system, expand access to quality services, improve hospital infrastructure and basic care, invest in prevention and health promotion, in addition to seeking solutions for specific public health challenges.
- **Social development:** Reduce social inequalities, promote social inclusion, guarantee basic rights, such as housing, food security, access to drinking water and basic sanitation, and combat poverty.

Planning for Brazil

The 1988 Constitution of the Federative Republic of Brazil states, in its Article 174, that: As the normative and regulating agent of the economic activity, the State shall perform, in the manner set forth by law, the functions of supervision, incentive and planning, ***the latter being binding for the public sector*** *and* ***indicative for the private sector****. In addition, its Paragraph 1, defines that the law shall establish the guidelines and bases for planning of the balanced national development, which shall incorporate and make compatible the national and regional development plans, while its Paragraph 2, sets that the law shall support and encourage cooperative activity and other forms of association.*

The 1988 Federal Constitution of Brazil also establishes that:

- Article 175. *The government is responsible for providing public utility services, either directly or by concession or permission, always through a bidding process, as established by law*.
- Article 176. *Mineral deposits, under exploitation or not, and other mineral resources and the hydraulic energy potentials form, for the purpose of exploitation or use, a property separate from that of the ground and belong to the Union, the concessionaire being guaranteed the ownership of the mined product*. Note that Paragraph 1 sets that *the prospecting and mining of mineral resources and the utilization of the potentials mentioned in the head provision may only take place with authorization or concession by the Union, in the national interest, by Brazilians or by a company organized under Brazilian law and having its headquarters and management in Brazil, in the manner set forth by law, which law shall establish specific conditions when such activities are to be conducted in the boundary zone or on indigenous lands*.
- Article 177. *The Union has a monopoly on the following:*
  - *I – prospecting and exploitation of deposits of petroleum; natural gas and of other fluid hydrocarbons;*
  - *II – refining of domestic or foreign petroleum;*
  - *III – import and export of the products and basic by-products resulting from the activities set forth in the preceding items;*

- *IV – ocean transportation of crude petroleum of domestic origin or of basic petroleum by products produced in the country, as well as pipeline transportation of crude petroleum, its by-products and natural gas of any origin;*
- *V – prospecting, mining, enrichment, reprocessing, industrialization, and trading of nuclear mineral ores and minerals and their by-products, with the exception of radioisotopes whose production, sale, and use may be authorized under permission, in accordance with subitems b and c of item XXIII of the heading of Article 21 of this Federal Constitution*.
- Paragraph 1. *The Union may contract with a state-owned company or a private enterprise to perform the activities provided for in items I through IV of this Article, with due regard for the conditions set forth by law*.

Founded on those constitutional pillars, Brazil established its legal and regulatory framework for planning, including its information bases, tools and public consultation processes.

Planning for Brazil involves defining short, medium and long-term goals and strategies to achieve national development goals. This includes:

- **Sectorial Plans:** Implementation of specific plans and programs for key areas such as infrastructure, education, health, agriculture, environment, energy and industry. These plans may include investment targets, capacity expansion, incentive policies and regulations.
- **Public-private partnerships:** Partnerships between the public and private sectors are encouraged to promote investment, innovation and development in strategic areas. This has involved concessions, privatizations, tax incentives and financing programs.
- **Regional development policies:** There is implementation of policies aimed at reducing regional disparities, promoting balanced and integrated development between the country's regions. This includes tax and financial incentives to attract investment and stimulate economic growth in less developed regions, as well as promoting infrastructure, education and access to basic services in these areas.
- **Sustainable development:** The integration of environmental and social concerns into the country's planning and development has involved the adoption of policies to protect the environment, promote renewable energy and energy efficiency, sustainable use of natural resources, encourage sustainable agriculture and conservation of biodiversity.
- **Innovation and technology:** Encouraging research, innovation and technological development as a central part of planning for Brazil has been taking place with several tax waivers. This includes creating incentives for companies and research institutions, supporting technology transfer, encouraging entrepreneurship and generating jobs and income, and creating startups.

- **Participation and governance:** The promotion of citizen participation and transparency in government policies and decisions has been taking place through public consultations, the creation of accountability mechanisms, the strengthening of control bodies and the promotion of efficient and ethical public administration.

It is important to emphasize that national development and planning for Brazil are continuous processes and subject to adjustments and adaptations over time, mostly indicative, as new demands and challenges arise. Specific strategies and priorities may vary based on different governments, economic contexts, and emerging societal needs.

1.1.4 INCORPORATION OF WOMEN AND YOUTH IN THE ENERGY SECTOR

The role of women and youth in the energy sector in Brazil is extremely important to promote diversity, innovation and sustainable development. Historically, the energy sector has been predominantly male, but more and more women are gaining space and playing key roles in this field.

Women have stood out in different areas of the energy sector, from research and development to the management and operation of energy projects. They bring unique perspectives and complementary skills, contributing to more balanced and effective decision-making. In addition, the presence of women in the energy sector is also fundamental for advancing gender equality and overcoming historical inequalities.

Likewise, young people play a crucial role in Brazil's energy sector. They represent a new generation of professionals with innovative ideas, digital skills and a growing awareness of the importance of sustainability. Young people have been drivers of change and have contributed to the transition to cleaner and renewable energy sources.

In addition, young people have an in-depth understanding of new technologies and their application in the energy sector. They are involved in community energy initiatives, developing renewable energy projects and promoting energy efficiency. Your active participation is essential to drive innovation, the discovery of more sustainable solutions and the creation of a more promising energy future.

However, there are still challenges to be overcome to ensure the full and equal participation of women and youth in the energy sector in Brazil. It is necessary to promote policies and programs that encourage inclusion and diversity, eliminating existing barriers and prejudices. In addition, it is critical to invest in education and training to provide women and youth with the skills they need to succeed in this ever-evolving industry.

The promotion of gender diversity in the electricity sector, especially in the STEM field (Science, Technology, Engineering and Mathematics), is a matter of great importance. The energy transition offers an opportunity to protect equity in this sector. However, according to data from the International Renewable Energy Agency (IRENA, 2019), women occupy only 22% of jobs in the field of electricity worldwide. In the area of renewable energies, this number rises to 32%.

In the Brazilian context, in recent years there have been programs and initiatives aimed at the inclusion of women and young people in the electricity sector. Energy buyers are collaborating with educational institutions to offer training programs targeted at women and young professionals interested in the energy field. With regard to academic training, it is important to note that most Brazilian universities offer few mandatory courses that consistently address the related topics mentioned above. Among the existing disciplines, renewable energy generation is highlighted, which is in line with the current high demand in this field.

1.1.5 CASE STUDIES

CASE STUDY 1: BUILDING CAPACITY ON HYDROGEN FOR PUBLIC AGENTS

In January 2021, Brazil was selected as the leading country on the theme of Energy Transition in the United Nations High Level Dialogue on Energy. This High-level Dialogue was launched with the aim of identifying ways to accelerate progress towards the goal of providing clean, sustainable, reliable and accessible energy for all. In this context, Brazil has decided to put forward the Brazilian Hydrogen Energy Compact, as a contribution to the global ongoing process to strengthen the foundations for a hydrogen economy aiming to create large-scale opportunities to decarbonize hard to abate sectors, seeking the possible synergies between clean electricity and low, zero or negative carbon fuels.

The Brazilian Hydrogen Compact intends to identify knowledge gaps and provide capacity building for both public and private sectors and increase specific professional training opportunities. This is critical for addressing the scale of the challenge ahead, by means of rapidly increasing the number of experts with a proper understanding of the hydrogen role in the energy transition, and of how they can get involved and support this process. This commitment aims to reduce risks related to a possible lack of skilled workers. Building Capacity is a part of a process to strengthen the foundations for a hydrogen economy, it might be an opportunity to develop and test new bold ideas that could foster investments along entire low carbon hydrogen value chain. To address this challenge, close collaboration between the Ministries of Education (MEC), Mines and Energy (MME), and Science, Technology and Innovation (MCTI) is a key issue.

The Brazilian Government recognized the "skill development challenge" in the axis "Capacity building and human capital formation", as part of the "Guidelines for National H2 Program (PNH2)", released in August 2021, and further related actions were developed and coordinated by MME. In this context, the Federal Government promoted two training events on hydrogen, via a partnership between MME, MEC, MCTI and the National School of Public Administration (ENAP).

ENAP was chosen to host those two training events on hydrogen for public agents due to its capacity building excellence for the Public Sector. For more than 30 years, ENAP has played a relevant role in innovating the culture of public administration and accelerating the transformation in learning, organizational, digital, social and economic management. The seminars provided an overview of the hydrogen market development and its implications for public policies, for public employees at the Federal, State and Municipal levels. Each seminar lasted 8 hours, covering different issues related to hydrogen and the National Hydrogen Program.

Boxes 1 and 2 (following pages) summarize the two seminars.

Box 1: "Hydrogen and The Hydrogen National Program" (Sep 13, 2022) – 8 hours

Seminar aims to enable the target audience to have an overview of world hydrogen market trends, subnational hydrogen policies, wide overview about hydrogen production projects in Brazil, national and subnational policies for hydrogen development in Brazil and International policies on hydrogen and findings based on the Global Hydrogen Review 2022 released by the International Energy Agency (IEA).

In this seminar, IEA was invited and presented its report Global Hydrogen Review 2022, providing an international overview to the audience.

It was offered as an in-class course or on-line.

Program:

- Opening
- Global Hydrogen Review 2022
- International Cooperation on Hydrogen
- Thematic Chambers (sub-committees) of National Hydrogen Program (PNH2)
  - Strengthening science and technology;
  - Training workers and human resources;
  - Energy planning;
  - Establishing a legal and regulatory framework;
  - Developing and opening up the market & competitiveness
- Announced Hydrogen State-Level Public Policies and Projects (States of Ceara and Rio de Janeiro)
- Announced Hydrogen State-Level Public Policies and Projects (States of Pernambuco and Bahia)
- Closing

Inscriptions: 150 people, of which 84.67% from federal institutions, 12.00% from State/District institutions and 3.33% from Municipality institutions.

See (in Portuguese): https://suap.enap.gov.br/vitrine/curso/1963/

Box 2: "Master in Business and Innovation in Green Hydrogen" (2023) – 360 hours

The course is offered to undergraduate from the areas of Engineering and Technology, who intend to qualify in the area of Green Hydrogen, or who already work in the area and would like to deepen their knowledge.

Green Hydrogen is a clean and renewable energy source that has attracted increasing interest in the last years, mainly due to its ability to reduce greenhouse gas emissions and contribute to the transition to a low-carbon economy. As a result, there is a growing demand for professionals specialized in Green Hydrogen technologies and renewable energy in general.

The competencies developed throughout the MBI are organized into three axes: Mindset for Innovation; Industrial Processes and Safety; and Green Hydrogen.

It was offered as an in-class course, but available online as well.

Program:

The development of skills on hydrogen in the "Master in Business and Innovation in Green Hydrogen" is structured through three-axis approach:

- Axis 1 - Mindset for Innovation (General Skills)
  - Problem Solving
  - Ideas and Innovation Creation
- Axis 2 – Industrial Processes and Safety (Chemical and Petrochemical Industry Skills)
  - Industrial Processes
  - Process Safety and Environmental Impacts
- Axis 3- Green Hydrogen (Specific skills)
  - Energy transition and Environment
  - Low Carbon Projects Coordination
  - Green Hydrogen value chain mapping
  - Green Hydrogen Production Process Management
  - Green Hydrogen Logistics (Storage and Transportation) Management
  - Usages for Green Hydrogen
  - Rules Application regarding Safety, Environment and Social Impacts
  - Process Management for Hydrogen Certification
  - Economic and Geopolitical Aspects for Hydrogen

See (in Portuguese): https://www.senaicimatec.com.br/en/cursos_pos/mbi-em-hidrogenio-verde/#/

Case Study 2: Hydrogen Skills Development for the Industry

As hydrogen gains momentum in the country and worldwide, several initiatives for skills development are established in different institutions in Brazil to accelerate learning and human capital formation in related issues of the hydrogen industry and its supply chain.

In this sense, the "Master in Business and Innovation in Green Hydrogen" Course was launched in 2023 by SENAI-CIMATEC, in Bahia State, aiming to provide basic knowledge and skills helping to build capacity for professionals to meet potential growing demand for hydrogen jobs in Brazil.

SENAI is one of the five largest Professional Education complexes in the world and the largest in Latin America, which has been training professionals for various areas of Brazilian industry since 1949. SENAI Bahia is part of SENAI National, and it stands out in the state of Bahia as a private institution that has been qualifying thousands of people for more than 70 years. There are more than 30 areas of competence, which have national and international partnerships with globally recognized institutions.

The Manufacturing and Technology Integrated Campus SENAI CIMATEC, in the state of Bahia, was inaugurated in March/2002 and is currently one of the most advanced centers for education, technology and innovation in the country. Supported by a staff of over 650 members, it hosts a Technical School, a Higher Education School and a Technology Center, all cooperating in a four-building structure of more than 35.000m².

SENAI CIMATEC School of Technology began operations in 2004, and currently offers several undergraduate degrees in engineering, and a series of Graduate programs, specializations, MBAs and master's and doctoral degrees. The Industrial Management and Technology (GETEC) and the Computational Modeling and Industrial Technology (MCTI) Master's Programs were inaugurated in 2008. MCTI incorporated a Doctorate in 2010, and then, in 2016, GETEC also opened a Doctoral Program. SENAI CIMATEC delivers highly qualified professionals to the various industrial sectors, supporting innovation and problem-solution, having earned the recognition of Brazilian Ministry of Education as the top engineering school in the North/Northeast Regions of Brazil for the past three years.

SENAI CIMATEC brings together complex ecosystems of Innovation and Technology Institutes and establishes partnerships and cooperation agreements with the private sector and universities, in Brazil and abroad. It is supported by EMBRAPII (Brazilian Company of Research and Industrial Innovation) which, since 2013, supports technological research institutions fostering the Brazilian industry innovation and is funded equally share by two federal bodies: the MCTI and MEC. This support allowed SENAI CIMATEC to develop its H2V Competence Center, for workforce training in the H2V theme, with projects, scientific initiation, masters and doctoral scholarship holders, leveraging the dissemination of knowledge in this area. Postgraduate Studies Approach explores synergies among the several components of SENAI CIMATEC ecosystem.

With the world moving toward cleaner energy sources, SENAI-CIMATEC recognized that the perspective for green hydrogen demand would increase significantly to reduce greenhouse gas emissions. Thereby, SENAI-

CIMATEC stated offering a “Master in Business and Innovation in Green Hydrogen”, to provide students with the knowledge and skills needed to meet this demand, driving innovation in the green hydrogen sector and helping to drive the energy transition to a more sustainable future.

Box 3 (following page) contains basic information on the “Master in Business and Innovation in Green Hydrogen” (MBI) offered by the SENAI-CIMATEC.

Box 3: "Master in Business and Innovation in Green Hydrogen" (2023) – 360 hours

The course is offered to undergraduate from the areas of Engineering and Technology, who intend to qualify in the area of Green Hydrogen, or who already work in the area and would like to deepen their knowledge.

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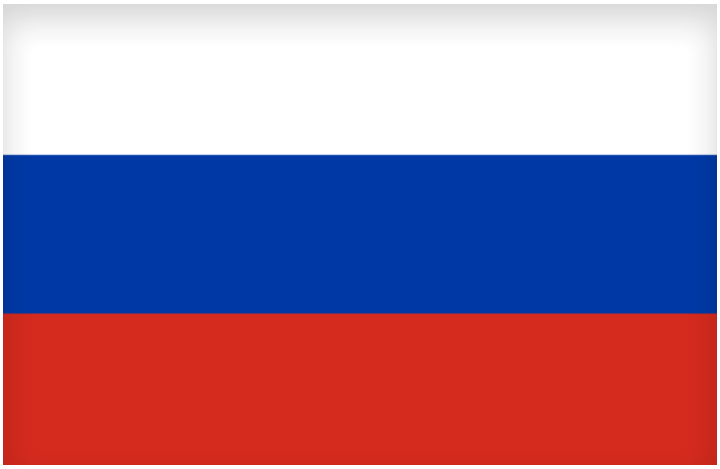
See (in Portuguese): https://www.senaicimatec.com.br/en/cursos_pos/mbi-em-hidrogenio-verde/#/

Brazilian Case Studies: Final Remarks

In addition to the training seminars on hydrogen at ENAP and to the MBI on Green Hydrogen at SENAI-CIMATEC, it is worth noting that public and private universities, research institutions, as well as business associations, offer several courses and training initiatives on low carbon hydrogen, covering both academic background and practical knowledge for skill formation.

RUSSIA



[1.2]

1.2.2 CURRENT DEMOGRAPHICS OF THE COUNTRY

Population

As of the beginning of 2023 the size of Russia's permanently settled population was estimated at 146.4 million people. The 2035 demographic forecast by the Federal State Statistics Service (Rosstat) projected three possible scenarios: pessimistic (the population is expected to decrease to 134.2 million) moderate (decrease to 142.9 million) and optimistic (increase to 150 million). In all scenarios, natural population growth shows negative dynamics. Long-term projections until 2100 also show a downward trend in Russia's population. Despite the fact that these forecasts assume quite a wide margin (from 67.4 million to 216.7 million people), Russian experts agree that the most likely scenario would be a decline to 137.5 million by the end of the century. This tendency is affected by continuing decline in birth rates, "aging" of the population, as well as migration processes. The average age of the country's residents in recent decades tends to increase. Thus, in 2010 it stood at 38.9 years, in 2015 - 39.4 years, and at the beginning of 2022 - 40.5 years. At the same time, every seventh Russian citizen at the beginning of 2022 (i.e. 16% of the country's population - about 23.3 million people), was 65 or older. Additionally, the total number of children and adolescents under the age of 16 is 22% less (7.7 million people in absolute terms) than the number of people, who surpassed the working age. As of the beginning of 2022 there were 67.7 million men and 77.9 million women in the Russian Federation. The trend towards an increase in the average age of the country's inhabitants, as well as a decrease in the overall population, led to a shortage of labour resources on the labour market and increased competition among employers.

Migration

Russia is a natural center of attraction for labour immigrants from abroad, especially from neighboring and closely located countries. Traditionally close historical and cultural ties with the former Soviet republics ensure strengthened economic cooperation and intensive migration processes between the Russian Federation and the neighboring states. Of the 667,922 foreign workers who arrived in Russia in 2021 and registered at their place of residence, 606,200 people (90.8%) came from the CIS countries, 8,300 (1.2%) - from the EU, 53,500 (8%) - from other countries. According to the Rosstat's forecast, annual migratory growth during 2022-

2036 will fluctuate around 250,000-260,000 people, but most likely it will not compensate for the natural population decline, which in turn will have an adverse effect on the working-age population.

Employment

As of May 2023, the total number of Russia's working-age population aged 15 or older stood at 75.8 million. 73.4 million of them were classified as economically active and 2.4 million - as unemployed. Among those employed, women accounted for 48.7%. The employment rate of rural residents (55.2%) was lower than that of urban residents (62.3%). As of May 2023, the average age of the unemployed aged 15 years and older (including retirees not employed but in search of employment/ready to work) was 37.7 years. Young people under 25 years old (including trainees not employed but in search of employment/ready to work) account for 19.1% of the unemployed population; persons aged 50 or over - for 21.6%. Persons without work experience account for 28.4% of the unemployed. The unemployment rate of women (3.4%) is higher than that of men (3%). Thus, based on the analysis of demographic and migration factors, as well as statistics on employment, a number of conclusions can be made. The trend towards an increase in the average age of the population, as well as a general decrease in the working-age population may lead to a shortage of labour resources and increased competition in the labour market among employers. To prevent the consequences of these tendencies a balanced state social policy towards employment is necessary.

Energy Policy

Priority directions of state energy policy in the Russian Federation are aimed at guaranteed energy security both at national and regional level, particularly in geostrategic areas, satisfaction of domestic demand for energy products and services, as well as the development of exports to friendly countries. The same importance is attached to transition to environmentally friendly and resource-saving energy in order to adapt to the global energy transition. As part of the implementation of the Paris Agreement, the Russian Government in 2021 has developed and approved the Strategy for Socio-Economic Low-Emission Development by 2050. It aims to cut down greenhouse gas (GHG) emissions by 70% by 2030 comparing to the levels of 1990, considering maximum absorbing capacities of forests and other ecosystems, and ensured the country's balanced and sustainable socio-economic development.

The fuel and energy sector should make an undoubted contribution to achieving this goal, as it is currently implementing a number of initiatives to reduce the anthropogenic impact on the environment and climate. Additionally, an Industry Climate Change Adaptation Plan for the fuel and energy sector was developed in 2021 in order to ensure sustainable development of the energy sector in the context of projected climate change. However, against the backdrop of changes in the global economy and the global climate agenda, Russia aims to achieve "transition to a more efficient, flexible and sustainable energy sector", which implies the development and introduction of new low-carbon technologies without abandoning traditional energy sources.

The Russian Federation has the largest initial recoverable reserves of natural gas and ranks sixth in the world in terms of oil reserves. Russia stands among the world leaders in terms of exports of energy resources, as well as in the development, utilization and export of nuclear energy technologies. Hydrocarbon resources constitute the cornerstone of Russia's energy balance. In 2021, most of Russia's primary energy consumption was covered by traditional energy sources: 54% from natural gas, 18% from oil, and 12% from coal. The rest came from other sources, including nuclear power and hydropower.

Sustainable Development Goals

In its policy planning the Russian Federation has always adhered to the principles of promoting the Sustainable Development Goals' full implementation, including ensuring universal access to reliable and affordable energy (SDG 7).

Despite the fact that Russia has universal access to energy, there is a targeted policy to promote the achievement of the Sustainable Development Goals, including universal access to reliable and affordable energy resources (SDG 7). On its part, the Russian Federation has ensured nation-wide access to energy across for its population. Nevertheless, the country is pursuing targeted policy to improve the efficiency of energy production and consumption, reliability and flexibility of the national energy system, with due regard to reducing greenhouse gas emissions from the fuel and energy complex (FEC).

In 2020, the total consumption of fuel and energy resources in the country amounted to 826.9 million tons of fuel equivalent (resulting in GHG emissions of 2,150 million tons of CO2-eq), which is 3% or 27 million tons of fuel equivalent less, in comparison with 2019. Thus, Russia's energy policy contributes to the SDG 7 target of doubling the global energy efficiency indicator.

The Russian Federation actively promotes international cooperation to facilitate access to clean energy research and technology (Target 7.a) and promotes infrastructure expansion and technology modernization for modern and sustainable energy supply (Target 7.b). Meanwhile, modernization and development of new low-carbon energy technologies will not be possible without promoting productive employment in the energy sector (SDG 8). A number of key Russian energy companies are actively engaged in implementing SDG Targets 8.5 (Ensure full and productive employment and decent work for all women and men, including young people and people with disabilities, and equal pay for work of equal value) and SDG 8.6 (Reduce the proportion of young people who are not working, learning and acquiring skills).

According to the results of the survey conducted as part of this study, companies in the Russian energy sector prioritize SDG 8 to increase productivity in the economy through diversification, technical modernization and innovation, including by focusing on high-value-added and labour-intensive sectors, as well as policies that promote productive activities, creation of decent jobs, entrepreneurship, creativeness and innovations, stimulation, official recognition and development of SMEs, including through the provision of access to financial services.

1.2.2 ENERGY SECTOR LABOUR MARKET

Employment in FEC with Breakdown to Industries

The level of employment in the FEC has remained stable over the last 5 years. Even during the COVID-19 pandemic it was possible to avoid a massive decline in the number of employees. At the end of 2022, the average number of employees amounted to 2,629 thousand people (3.5% of the total number of employed in Russia).

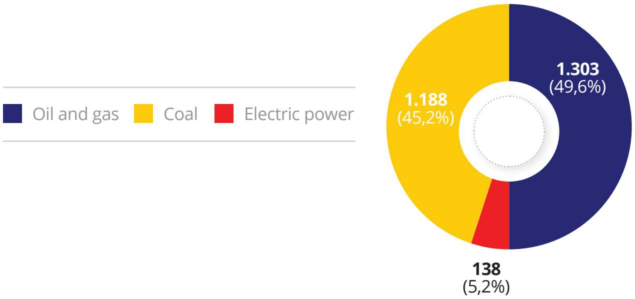


Figure 20: Number of Employees in Fuel and Energy Complex, 1 000 People

According to the data coming from the FEC state information system, about 35,000 people were employed in the field of electricity generation by nuclear power plants as of the end of 2022.

Main Characteristics of the FEC Labour Resources

Age Structure

The average age of personnel in the Russian FEC today stands at 42 years, which corresponds to the average age of all the individuals involved in the economic activity. The share of persons under the age of 35 in the energy sector is 25%, with the oil and gas and nuclear industries being the leaders in terms of the composition of young people in the overall structure of the workforce.

Figure 21: Share of Youth (35 and Below)

Gender Structure

The number of male employees in the Russian energy sector noticeably exceeds the number of females. On average, the share of men employed in the FEC is about 70%, while the share of women is about 30%. In the coal sector the gap in the representation of men and women is particularly noticeable: 78.3% vs. 21.7%, respectively. Among the employees of the nuclear industry **(State Atomic Energy Corporation “Rosatom”)**, the share of men was 68%, women - 32%. Although the percentage ratio of men and women in the Russian FEC is comparable to global indicators (in 2022 the share of women in the global FEC amounted to 28%), the existing gender gap in the FEC is primarily driven by the government’s social policy aimed at preserving women’s health. Legislation prevents women from working in professions involving heavy physical labour. For the same reasons the FEC regulations do not provide for the employment of women in geological exploration and underground work in the mining industry, oil refining and gas processing, repair of equipment of power plants and power grids, etc.

Education Levels

According to the Ministry of Energy of the Russian Federation, 47,5% of the FEC employees have higher education degree, 30,4% - secondary professional education.

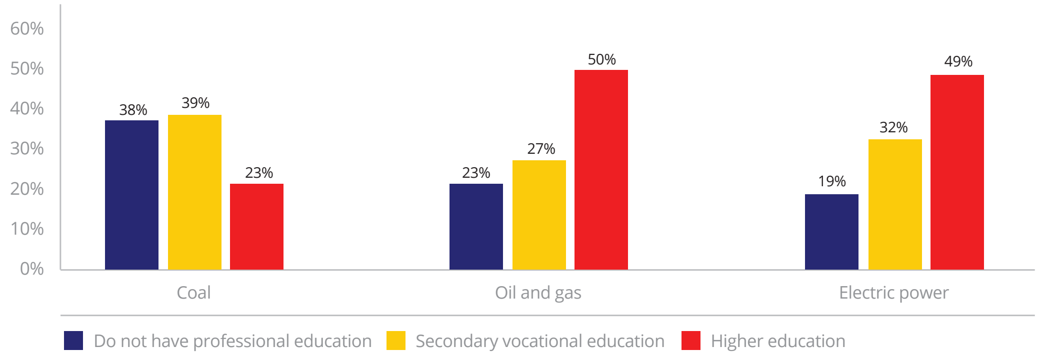


Figure 22: Structure of Personnel in the FEC Industries Based on the Education Level

Payment for Labour

Government policy in the Russian Federation is aimed at ensuring a competitive level of wages and social packages. Those provisions are ensured by national development goal "Decent, efficient labour and successful entrepreneurship" of the Unified Plan for Achieving the National Development Goals of the Russian Federation by 2024 and for the planning period of up to 2030, approved by the Government of the Russian Federation Order No. 2765-r dated 01.10.2021. The size of wages in the Russian Federation is characterized by strong sectoral and territorial differentiation, dictated by economic specialization of the country's regions. At the same time, over the last 20 years, the highest level of wages has been observed in the field of energy resources export. In oil and gas production, wages are higher than the national average - as a rule, by 2-2.5 times. A positive trend in 2021-2022 is seen in the coal industry - the growth rate of real wages (by 8% per year) exceeded the Russian average (no more than 1% per year), in the electric power industry the growth rate is at the level of the national average. Large companies in the fuel and energy sector act as socially responsible employers implementing a policy of attracting and retaining highly qualified personnel and young specialists, primarily through sustaining attractive salaries.

Sectoral System of Professional Qualifications

The Russian Federation has built a national system of professional qualifications, aiming at synchronizing the labour market needs (i.e., employers' requirements for employees' qualifications) with the capabilities of the education and training system.

The system of professional qualifications has three key components:

i. Professional standards (characteristics of qualifications required for an employee to perform a certain type of professional activity, including specific labour function);
ii. Independent qualification assessment (a procedure to confirm the compliance of applicant's qualifications with the provisions of professional standard or qualification requirements envisaged by the Russian legislation, that is conducted by specialized center for qualifications assessment);
iii. accreditation of educational programs conducted by employers (recognition of the quality and level of training of graduates who have mastered educational programs that meet the labour market requirements as well as professional standards for workers and employees of the relevant specialization.

The authority to develop and update professional standards, monitor the labour market, organize independent qualification assessments, examination of educational standards and programs is vested in professional qualifications councils, established under the auspices of employers' associations either on sectoral or professional basis. There are three professional qualifications councils in the energy sector: in the oil and gas complex, in the electric power industry and in the nuclear industry. The Energy Strategy of the Russian Federation for the period up to 2035 sets out a strategic goal to develop a sectoral system of professional qualifications taking into account the priority areas of the FEC technological development and to ensure its coherence with the professional education system.

The indicators for the implementation of these tasks include number of employees covered by approved professional standards (all key professional activities in the energy sector are accounted) and the ratio of personnel training costs to the wage fund (per year). Maintaining and improving the quality of labour resources requires investment, as labour productivity and, consequently, business profitability depend on it. Among the FEC industries, additional incentives for investment in employee training are: the presence of key companies in global markets where competition is high, health and safety requirements and the global importance attached to the ESG agenda.

The 2022 performance figures under the above-mentioned indicator (number of employees covered by professional standards across main sectors of the FEC), obtained during the survey of the respective organizations, demonstrate positive dynamics compared to the figures for 2021. In the oil and gas sector these are 56.1% (vs. 54.2% in 2021), in the electric power sector - 59.4% (vs. 56.4% in 2021), in the coal sector - 38.3% (vs. 24.7% in 2021). In turn, the second indicator reflects he ratio of personnel training costs to the payroll fund and constitutes a tool for assessing an increase in investment in human capital by industry companies. The actual values of the indicator for 2022, obtained in the course of the survey of fuel and energy complex organizations, demonstrate positive dynamics compared to the indicators of 2021. Oil and gas industry show figures up to 1.5 (vs. 0.9 in 2021); the electric power industry - 0.8 (vs. 0.6 in 2021), coal industry - 1.0 (vs. 0.4 in 2021).

Social Partnerships

Institutions of social partnership act as one of the key drivers of welfare of the working environment. In accordance with the labour legislation of the Russian Federation, the system of relations between employees (employee representatives), employers (employer representatives), state authorities, and local self-government bodies constitutes the system of social partnership. In each sector, the interests of companies are protected by sectoral associations of employers and those of employees by sectoral trade unions.

The protection of workers' rights and interests is ensured, in particular, by agreements concluded between trade unions and employers at the federal, interregional, regional, sectoral (intersectoral) and local levels of social partnership. These are documents that define the employers' social responsibility standards, primarily in such areas as wages, compensation and benefits. Such agreements signed by the parties to social partnership and entered in force, are currently covering all major TEC sections. At the local level of social partnership, i.e., in specific employing organizations, the parties enter into collective agreements defining agreed terms and conditions of social guarantees for employees.

Social and human resources policy represents an important element of the activities of the FEC companies', operating in the Russian market. Corporate support measures include premium medical insurance programs, improving of housing conditions (from preferential mortgage terms to social housing rent), payment of transportation costs, financial support for employees' families, etc. As a rule, the system of employee incentives is aimed at targeted solutions, depending on the specific needs of individual categories of employees. The creation of the most comfortable conditions for employees should increase labour productivity and employee loyalty, suiting economic interests of the employing companies. Most of the operators of the Russian TEC have a wide range of corporate social programs, which helps attract and retain qualified personnel in energy companies.

The Dynamics and Drivers

One of the key trends of the modern labour market in the TEC is the relevance of traditional energy. Investments in fossil fuels remain at a high level, and traditional energy continues to be a profitable and promising sector of the economy, which requires qualified personnel for stable functioning. This trend reveals that the demand for qualified specialists for the key sectors of the TEC should remain stable in the near future.

At the same time, the companies represented in the TEC market are noticing a shortage of engineers at all levels - from highly qualified staff to operating personnel. According to the survey conducted as part of this study, about 40% of fuel and energy companies have difficulties in finding engineering and technical personnel, both with secondary professional and higher education. One of the reasons for this being the low popularity of most engineering and technical specialties among talented young people.

Another reason for the shortage of personnel can be the high level of competition for employees between industry companies. This is specifically the case for the ten key regions with the most capacious TEC labour markets (where the share of fuel and energy complex employees in the total number of employees ranges from 10 to 35%).

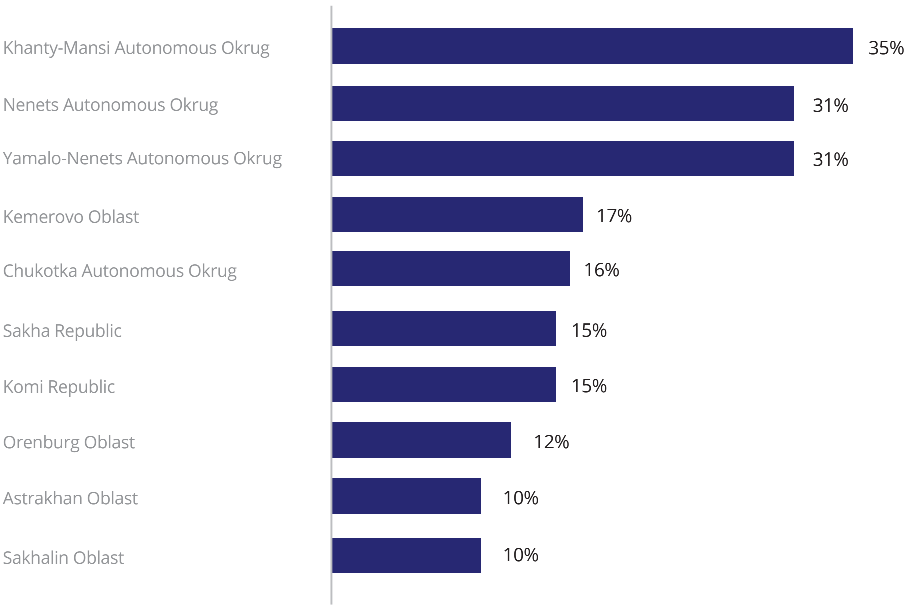


Figure 23: Top 10 Regions Based on the Number of Employed in the FEC

Among the FEC specialists in demand are operating engineers, technical support specialists, production line operators, chief project engineers, critical work specialties for power plants, heat networks and repair services. In turn, coal mining companies note a shortage of mine workers and electricians, as well as mining excavation machine operators.

As for the nuclear industry, the most in-demand workers are currently specialists in the field of nuclear reactors and materials, nuclear physics and technology, design, operation and engineering of nuclear power plants. It is also necessary to take into account the established trend for energy transition. Russian energy companies are committed to the SDGs and ESG agenda and guided by the principles of sustainable development in their activities. They also fully associate themselves with the goals and values of the climate agenda, declaring plans to achieve carbon neutrality by 2050, and develop and implement the highest standards of environmental protection and industrial safety.

The realization of these goals by companies is inextricably linked to the development and implementation of new areas and technologies in their operations that reduce harmful emissions and the negative impact on the environment. Among these are the introduction of new seismic exploration and drilling technologies that aim to reduce the negative impact on environment; development of technologies for capturing, utilizing and storing carbon dioxide in the production of liquefied natural gas and hydrogen production; operationalization of renewable energy sources based on solar panels and wind turbines; production of high-tech equipment to improve the employee's safety at the working place. Companies in the energy sector are actively introducing artificial intelligence (AI) and information modelling technologies (BIM technologies) for the design and construction of new energy facilities, as well as artificial intelligence technologies. Additionally, measures are taken to ensure information security on critical infrastructure, including power generation, transmission and distribution facilities.

This transformation entails the emergence of a whole layer of new promising professions at the intersection of technology and energy, particularly: a specialist in digital (automated) management of energy facilities; a specialist in renewable (alternative) energy; a specialist in cybersecurity of energy facilities; a specialist in building highly automated networks; a specialist in information modeling; business architects and analysts, data architects. They also represent some of the most in-demand professions in the energy industry at the moment, and this demand will continue to grow. In addition, due to active implementation of smart grid technologies, the profession of system engineer of smart energy systems is becoming increasingly popular. In light of the development of hydrogen energy, there is a growing need for specialists in the field of hydrogen production, use, storage and transportation.

At least 60% of the FEC companies surveyed for this study feel the need for employees with specialties related to energy transition. At the same time, it is noted that there are specialists whose qualifications meet the requirements of energy transition on the labour market, but such specialists are in short supply. This creates the need for consistent adaptation of the personnel training system to the current trend of "green" transformation of the fuel and energy complex. Despite the fact that the energy transition may entail a number of risks, including the reduction of employment in areas related to traditional energy sources, and socio-economic problems in the so-called single-industry towns, the trend towards low-carbon sustainable development opens new opportunities and prospects for the development of the labour market and human resources potential in the fuel and energy sector.

1.2.3 SYSTEM OF PROFESSIONAL EDUCATION FOR THE FEC

In accordance with the Russian legislation in the field of education, the system of personnel training for industries, including the FEC, build upon secondary vocational education (programs for training of skilled workers, clerks, and middle-level specialists) and higher education (under bachelor's, specialist, master's, and postgraduate programs).

Secondary Vocational Education

Training of personnel for the FEC is carried out across 10 professions and 11 specialties in the field of electric and thermal power engineering, 2 specialties in the field of nuclear power engineering, as well as 10 professions and 12 specialties in the field of applied geology, mining, oil and gas engineering and geodesics. In the 2022/23 academic year, about 111 thousand people studied in organizations engaged in educational activities in professions and specialties of secondary vocational education in the field of electric and thermal power engineering, about 63 thousand people studied in the field of applied geology, mining, oil and gas, geodesy, and about 1 thousand people studied in the field of nuclear power engineering. In 2022, the output of qualified employees and mid-level specialists in the field of electric and heat power engineering amounted to about 25 thousand people, in the field of applied geology, mining, oil and gas, geodesy - about 14 thousand people, and in the field of nuclear energy - 200 people.

In 2020-2021, about 70% of FEC secondary vocational education graduates have managed to find employment in accordance with their specialty.

Higher Education

Currently, about 180 Russian higher education institutes (HEIs) graduate young professionals in areas and specialties relevant to the FEC, including more than 50 for the oil and gas sector and more than 30 for the coal industry. In the 2022/23 academic year, about 108,000 people studied at higher education institutions in the field of electric and thermal power engineering, about 60,000 people - in the field of oil and gas, geology, geodesy, 23,500 people - in the field of mining, and about 8,000 people - in the field of nuclear energy.

In 2022, graduation in training areas and specialties in the field of electric and thermal power engineering amounted to 22,000 people, in oil and gas, geology, geodesics – to 12,000 people, in the field of mining – up to 3,000 people, in nuclear power engineering – 1,400 people. According to experts, in 2020-2021 the percentage of university graduates who have managed to find employment in accordance with their professional specialty remained positive and amounted to about 90%.

For the nuclear energy sector this figure stands at 86,4% (of the 3,400 people graduated from respective HEIs in 2018-2020, 2,900 have managed to find employment in accordance with their professional specialty).

The leading universities in terms of the number of students in the field of electric and thermal power engineering are NRU “Moscow Power Engineering Institute” (MPEI), Kazan State Power Engineering University, Ivanovo State Power Engineering University; in the field of mining - Kuzbass State Technical University, Ural State Mining University, National Research Technological University “Moscow Institute of Steel and Alloys”, St. Petersburg Mining University; in the field of oil and gas - Tyumen Industrial University, Ufa State Oil Technical University, Gubkin Russian State University of Oil and Gas (National Research University). The majority of specialized universities are located in the regions where fuel and energy complex workers are in most demand. Recently, there is notable tendency towards the introduction of new educational programs and specialties related to changes in the global energy sector in the context of the energy transition. According to the Renewable Energy Development Association, more than 35 universities are engaged in training specialists in the field of RES. Programs for training specialists in the field of hydrogen energy are being implemented (e.g. specialization “hydrogen energy” at the National Research University “Higher School of Economics”, master’s program “Materials and Technologies of Hydrogen Energy” at the Ural Federal University etc.)

Special institutes and departments, scientific and educational centers on low-carbon energy sources and renewable energy operate on the basis of higher education institutions. For example, the CIS International Scientific and Educational Center for Renewable Energy Sources and Energy Efficiency was opened at the National Research University "Moscow Power Engineering Institute". Training laboratories for research on renewable energy sources are being established, and experimental research on alternative energy is being carried out. For example, the Volga Region State Technological University has an Energy Efficiency Demonstration Center, and the Sevastopol State University has opened a student testing ground for alternative energy sources.

1.2.4 ENGAGEMENT OF POTENTIAL EMPLOYERS IN PROFESSIONAL EDUCATION

Currently, there is a generally successful practice of interaction between business and educational sector. This implies that educational institutions perform as a provisioner for entities operating in the industry, and trains specialists at the request and with the assistance of employers, including internships in companies, grants, corporate scholarships. At the same time, a number of problems remain. Specifically, according to the recent survey, more than 40% of respondents evaluated the current level of cooperation between business and educational organizations as average. Meanwhile, the current legislation on vocational education enables employers to participate in the organization of personnel training, including the following mechanisms of interaction with educational organizations:

- targeted training of specialists for the needs of employers (needs-based training);
- providing opportunities for practical training within employers' facilities;
- participation of employers in the development of educational standards, lists of specialties and educational programs;
- inclusion of employers' representatives in state examination commissions (they should constitute at least 50% of the commission);
- engagement of working specialists as tutors;
- accreditation of educational programs by employers;
- establishment of university departments within employing organizations;
- transfer of equipment from employers to the HEIs.

The Ministry of Education and Science of the Russian Federation assesses the effectiveness of the implementation of these conditions, primarily through annual monitoring of respective HEIs' activities, and based on the information provided by HEIs. However, such monitoring currently does not provide for feedback tools from sectoral organizations. It is important to emphasize that in Russia there is a growing number of associations and scientific and educational consortiums that promote cooperation between universities, research centers and other stakeholders, including companies in the energy sector.

Cooperation between major Russian energy companies and state universities is also developing. Most of FEC companies have their affiliated universities in the regions. Such a system of relations implies support and resource provision to universities, and the educational institutions are reoriented towards targeted training of personnel for the energy sector's backbone companies. Potential employers take part in the development and implementation of educational programs using their own resources, and additional practice-oriented activities are included in the educational programs. When the time comes, FEC companies most often consider graduates of these universities for employment. This practice is an example of an effective practical solution to the problems of synchronizing the interests of regions, industry companies and educational organizations, since it also facilitates local distribution of graduates.

1.2.5 WOMEN AND YOUTH REPRESENTATION IN FEC

In the context of global efforts to implement SDG 8, particularly targets 8.5 "Full employment and decent work with equal pay", 8.6 "Work, training and education for youth", 8.b "Development of a global strategy for youth employment", etc., it is relevant to comprehensively promote employment of women and youth. There has been a growing number of initiatives established in Russia aimed at promoting the principles of gender balance in the Russian FEC. To name a few: the Association of FEC Professionals "Women in Energy", the discussion club "Women in Energy" of the Russian National Committee of the International Council on Large Electricity Systems of High Voltage (CIGRE), the Fund for Support and Development of Women's Initiatives "Association of Women in the Nuclear Industry".

Advanced Russian energy companies promote the idea of inclusiveness and gender equality in their corporate culture and at the global level. For example, women currently represent 33% of State Atomic Energy Corporation "Rosatom" employees, including 22% of top management positions and 23% of engineering and IT positions. The Corporation is a member of the Nuclear Energy Agency (NEA) working group on gender balance. Within its framework the first international study on gender balance in the nuclear industry was conducted in 2021. In

April 2023 the Corporate Academy of Rosatom completed the pilot project of the leadership program for female executives "[non-]Visible Power". Thirty-eight managers of Rosatom's subsidiaries and organizations participated in the project. With regard to youth policy, survey conducted as part of this study among the major FEC companies has shown, that about 80% of them provide special training and/or motivational programs focused exclusively on young specialists. Almost all FEC companies have youth councils and communities that are involved in physical fitness, tourism, cultural and mass events, social volunteering, career guidance and other youth policy projects. At the same time, more than 70% of the surveyed companies implement a mentoring mechanism aimed at the adaptation and motivation of young employees.

Talented young people are also attracted to the energy industry as part of the National Plan of Youth Events aimed at popularizing the FEC. The key projects of the Plan are the "CASE-IN" International Engineering Championship and the "Energy tour" project for the development of youth industrial tourism (for more details, see Appendix). State also supports dialogue between youth and the industry community. A Youth Day is held annually as part of the Russian Energy Week International Forum gathers more than 1.5 thousand young specialists, students and schoolchildren.

1.2.6 CASE STUDY

PROFESSIONAL EDUCATION AND ENERGY LABOUR MARKET DEVELOPMENT

1. Best Practices of Cooperation Between Business And Educational Facilities

International Engineering Championship "CASE-IN"

The "CASE-IN" is the largest project in Russia and CIS countries aimed at young people seeking professional development in the FEC, mineral resources, nuclear and related industries. As part of the championship, the contestants, united in cross-functional teams, solve engineering cases prepared by the leading companies of the industry (partners to the "CASE-IN"). The tasks are close to real-life situations and are devoted to the trending aspects of the industry's development.

In the development of projects, young people get acquainted with the activities of the major companies and professions of the section, learn important professional skills and competencies, gain practical experience, learn to present their ideas and speak in public.
Schoolchildren, students of universities and professional educational organizations, as well as young professionals under the age of 35 can compete for the championship prizes.

The competition is held simultaneously in several areas: School League, Student League, League of Young Specialists, League of Working Specialties and Special League. Medals and cups are played in two stages: in May-June the leaders of the main season are determined, in December - the Fall Cup.

In 2022, the "CASE-IN" championship celebrated its 10th anniversary. During this time, more than 50,000 future and young professionals from across Russia and foreign countries participated in the project. More than 170 industry companies have supported the championship for 10 years. The solutions of contestants at different stages of the competition were evaluated by 8 thousand experts. "CASE-IN" in the regions was coordinated by about 1 thousand tutors from universities, schools and technical colleges.

The winners and runners-up of the championship receive valuable prizes. The rewards may include privileges for admission to the master's and postgraduate programs of 24 universities, internships and practices in partner companies with the possibility of subsequent employment. Schoolchildren-winners get additional state exam points when entering bachelor's degree programs at one of the 109 participation universities covering 53 regions of Russia. The Young Professionals League triumphants rewarded with new opportunities for career and professional growth, as well as inclusion in the management personnel reserve of companies. The authors of the best ideas participate in industry-specific youth educational forums and travel around Russia as part of the program "More than a Journey".

2. Best Practices on the Cooperation Between Government, Educational Facilities and Business

The Scientific and Educational Consortium "Energy of the Future" (hereinafter referred to as the Consortium)

Consortium was established in September 2022 as a platform for integration of educational, scientific and technological potential of the country's leading educational and research centers to promote scientific and technological development of the Russian Fuel and Energy Complex. The Consortium was initiated by the Federal State Budgetary Organization "Russian Energy Agency" of the Ministry of Energy of the Russian Federation. The Consortium includes the following universities: Plekhanov Russian University of Economics, National Research Institute "Moscow Power Engineering University", Gubkin Russian State University of Oil and Gas, Moscow State Institute of International Relations of the Ministry of Foreign Affairs of the Russian Federation, Financial University under the Government of the Russian Federation.

The goals of the Consortium are to train highly professional personnel for the fuel and energy industries and to promote the development of scientific and technical potential of the fuel and energy industries. The key areas of the Consortium's activities include the preparation of information and analytical products for making managerial decisions for the FEC industries, as well as joint research and development work in the interests of companies in the FEC industries.

The Consortium activities included educational programs of additional professional education on the problems of modern power engineering and an open lecture hall to popularize knowledge in power engineering and attract young researchers into scientific activities.

3. Best Practices on Professional Education in Major Companies.

Industry Professional Excellency Championship "AtomSkills"

"AtomSkills" is an annual nuclear industry championship for operators and engineers. It has been organized by State Atomic Energy Corporation "Rosatom"since 2016. The first championship was held in 10 competencies and brought together about 450 specialists and industry experts. Today it is one of the world's largest championships. It brings together more than 2,000 professionals who compete in 40 competencies. Within the professional community, participation in the "AtomSkills" Championship is an important factor in experts' positioning, which in turn opens up additional prospects for career growth. The AtomSkills-2023 championship will present the best practices personnel training in the nuclear power industry in the following areas: "Rosatom's Industry Competence Centers", "Nuclear Welding Schools", the Federal Project "Professionality", "Rosatom Juniors", BarCamp "Mission: Talents" and others.

In 2022, AtomSkills attracted more than 1.4 thousand participants from 40 regions of Russia, who competed in 39 professional competencies. 16 teams from Rosatom's electric power, engineering, machine-building, fuel and other divisions participated. The championship was attended by about 200 students from 9 universities, headed by Rosatom's key university - National Research Nuclear University «Moscow Engineering Physics Institute». In addition to nuclear industry enterprises, teams from "Russian Railways", State Corporation for Assistance to Development, Production and Export of Advanced Technology, "SIBUR" and other companies also took part in the competition. The competences of "Additive Technologies", "Digital PSR-Enterprise" and "Quantum Technologies" were presented for the first time. Since 2019, the "Engineer Thinking. Karakuri" positions as one of the core competencies at professional skill championships, both global and national. In the art of karakuri there are no limitations in age and engineering experience of participants. Even a child can offer a simple and ingenious solution if she/he is fascinated by technology and is able to creatively approach the task at hand. The “KaraKURAZH” competition, which has been held annually for family teams from all over the country since 2020, is one of the projects of State Atomic Energy Corporation “Rosatom”. In 2022, more than 60 families from 20 regions of Russia took part in the festival. AtomSkills Industry Skills Championships are a tool for developing the professional environment, facilitating the exchange of knowledge and experience between representatives of generations, and uniting specialists, students and schoolchildren into a single ecosystem for training and developing workers and engineering personnel in Russia. The introduction of new standards of professional skills allows Rosatom and its enterprises to occupy new niches in the market, increasing the competitiveness of the nuclear industry and the entire Russian industry as a whole.

4. Best Practices in Enabling Women’s Career Growth in FEC

Discussion Club “Women in Energy” of the Russian National Committee of the International Council on Large Electricity Systems of High Voltage (CIGRE)

In recent years, there has been a noticeable increase in the number of initiatives in Russia that aim to promote the principles of gender balance in the FEC, namely - to advocate for increased representation of women in the industry. Among such initiatives is the “Women in Energy” Discussion Club. This association is a key initiative to support women in the electric power industry. It aims to develop mutual support within the industry’s women’s community under the unifying role of the Ministry of Energy of the Russian Federation.

The main activities of the community include:

- Practical consolidation of information on the most relevant issues of the industry agenda, collected from various platforms;
- A general meeting of the club (at least once a year);
- Accumulation and exchange of data to identify positive and negative trends;
- maintaining an open information platform (placed at Council’s website) with thematic information from Russian and international sources, plans and results of the community’s activities.

In May 2023, the fourth online meeting of the Women in Energy Community was held. It discussed strategic development plans for promoting women’s rights in the energy industry, including the popularization of science and formation of role models for women scientists, creation of an appropriate human and intellectual pool, strengthening career positions for women scientists, etc. These issues constitute the current agenda of the Community. Work on tracking and implementing of best practices to ensure a comfortable balance of “family” and “professional” components, as well as on supporting and involving women in scientific and technical activities and STEM education continues.

5. Best Practices on Youth Engagement in Energy

Energotour

In 2022, the Ministry of Energy of the Russian Federation initiated the development of a special industry project “Energotour” as part of the government-implemented youth tourism program “More than a Trip”. The project is aimed at finalists and winners of academic competitions, contests, volunteer and creative initiatives at the corporate and federal levels and gives talented young people opportunities to visit major FEC objects and get to know the activities of industry companies from the inside. In 2022, more than 350 students in 9 groups visited such facilities, including substations, nuclear power plants, hydroelectric power plants, petrochemical production facilities etc. In 2023, it is planned to expand the geography of the project to include new production facilities. It is expected that in 2023 about 1,000 people will visit fuel and energy facilities within the framework of the project.

INDIA

[1.3]

1.3.1 CURRENT DEMOGRAPHICS

India is working towards a low carbon emission pathway while simultaneously endeavoring to achieve sustainable development goals. It's Nationally Determined Contribution (NDC) are taking forward the vision of a sustainable lifestyle and climate justice to protect the poor and vulnerable from adverse impacts of climate change. India's NDC centres around policies and programmes on promotion of clean energy, especially renewable energy, and enhancement of energy efficiency for achieving the goal of sustainable Energy Transition.

At the 26th session of the Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Glasgow, United Kingdom, India expressed its intention to intensify its climate action by presenting to the world five nectar elements (Panchamrit) of India's climate action.1India is making concerted efforts to achieve its target of achieving 50% energy capacity from non-fossil sources by 2030. This could create 3.4 million new job opportunities (of short or long duration) mostly in the wind and on-grid solar energy sectors.

1.3.2 LABOUR MARKET ANALYSIS IN THE ENERGY SECTOR

The Ministry of Skill Development and Entrepreneurship (MSDE) was formed by the Government of India in 2014 to coordinate all skill development efforts in the country. Since its inception, MSDE has undertaken significant initiatives and reforms to develop an agile and sensitive skill ecosystem, including standardization, institutionalization of the National Skill Qualification Framework (NSQF); formalizing the policy framework through the National Skill Development Policy (2015); Common Norms for Skill Development Schemes; launching of new programmes and schemes; creating new skill infrastructure and upgrading the existing institutions; partnering with States; building industry connect; and enhancing the aspiration value of skilling.

The Ministry aims to bridge the gap between demand and supply of skilled manpower and nurture the skill ecosystem, to build new skills and capacity not only for existing jobs but also for jobs that are to come up in future, including in new energy, climate resilience and sustainability.

One of the initiatives under MSDE is the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) aimed at creating an industry ready workforce5. Since 2015, nearly 1.4 Crore candidates have been trained under short duration training or oriented through Recognition of Prior Learning (RPL) under the scheme. Around 4.5 Lakh candidates have been trained/oriented under roles related to green jobs and sustainability under this scheme.

National Skill Development Corporation (NSDC), under the aegis of MSDE, has, established 37 Sector Skill Councils (SSCs) which cover major sectors of the economy to fulfil their skilling needs.6SSCs create National Occupational Standards (NOS) and NSQF aligned packs (QPs) based on a competency framework. They are also responsible for conducting the Trainers training programs, skill gap studies and certify trainees on the Qualification approved by the skill regulator - National Council for Vocational Education and Training (NCVET).7Reaffirming its commitment to build a scalable, transparent and sustainable mechanism for skill development efforts, the SSCs focus on strengthening the industry connect to comprehend the evolving skill requirements, identify emerging trends and create job roles in line with the new skills required. They also develop content and curriculum for various Qualifications in regional languages to address language barriers and enhance equitable access of skilling to all sections of the society.

1.3.3 LABOUR MARKET ANALYSIS IN THE ENERGY SECTOR

To address the skilled manpower issue associated with energy transition and sustainable development, a separate sector skill council, “Skill Council for Green Jobs” has been set up for the purpose of developing competencies/skills in the domain of renewable energy, sustainable development, and climate change. The Skill Council for Green Jobs is co-promoted by MSDE, Ministry of New and Renewable Energy (MNRE) and Confederation of Indian Industry (CII).

MSDE and institutions under its aegis are proactively engaged in developing enabling frameworks, courses, curriculums, and training delivery mechanism for green jobs, including in the emerging areas Green Hydrogen, Green Steel, Electric Mobility etc. to be offered under both long-term training at Industrial Training Institutes (ITIs) and as short-term training under various Government programs. These roles would complement existing job roles around Waste Management, Recycling, Solar, Wind Energy, Agri-residue management, etc.

As per terminology adopted by SCGJ,‘Green jobs’ refer to a class of jobs that directly have a positive impact on the planet and contribute to overall environmental welfare. These are jobs that seek to use or develop renewable forms of energy, conserve resources, ensure energy efficient means, regulate waste management, and promote sustainable development. Green jobs need to be employed in the context of a just transition towards sustainable development.9

Green skills intensity refers to the extent to which different countries, sectors, and jobs incorporate green skills. The higher the green skills intensity and more the number of green jobs, the smoother will be the green transition of the economy. Over the last few years, there has been a steady increase across green skills intensity and the number of green jobs.

1.3.4 INCORPORATION OF WOMEN AND YOUTH IN THE ENERGY SECTOR

The Green Skill Development Programme (GSDP) of Ministry of Environment, Forest and Climate Change has the objective of skilling the youth of India especially dropouts and in increasing the availability of skilled workforce in the environment and forest sector. The programme endeavours to develop green skilled workers having technical knowledge and commitment to sustainable development.

Ministry of New and Renewable Energy (MNRE) has announced schemes and policies such as Production Linked Incentive Scheme 'National Programme on High Efficiency Solar PV Modules', Solar Park scheme, Roof Top Solar scheme, National Bioenergy Programme, Pradhan Mantri Kisan Urja Suraksha evamUtthanMahabhiyan (PM-KUSUM) etc. which are boosting the employment in the renewable energy sector. Jobs are being created through the Research and Development (R&D) activities across industry and academia. Decentralised Renewable Energy (DRE) livelihood applications also boost local employment opportunities. In recent years, upcoming clean energy technologies such as solar water pumps, mini and micro grids, floating solar plants, solar-wind hybrid plants and battery storage are enhancing the creation of jobs.

The National Green Hydrogen Mission (NGHM) launched by the Government will propel domestic manufacturing of electrolysers, construction of hydrogen production units, and R&D activities to meet the industry demand which is expected to create over 6,00,000 jobs by 2030.

MNRE is developing qualified and skilled manpower in Renewable Energy area through its Human Resource Development Programme:

i. Surya Mitra Skill Development Programme (Solar PV technician training) was launched by MNRE in 2015 for boosting employment opportunities by creating skilled manpower for installation, operation, and maintenance of solar power projects. Over 53000suryamitrashave been trained so far under this programme.

ii. Jal-Urjamitra Skill Development Programme provides training focussed on installation, operation, repair, and maintenance of Small Hydro Power Projects.
iii. Vayumitra Skill Development Programme (VSDP)creates skilled and trained manpower for maintenance of Wind power projects.
iv. National Renewable Energy Fellowships at M. Tech, M.Sc., and Ph. Dlevels are provided to students to enrolling the courses on renewable energy technologies.
v. MNRE had also supported six months training programme specifically for semi-literate women of rural areas on assembly, installation, operation and maintenance of solar lanterns, lamps, etc.

India's energy landscape is undergoing a significant transformation, driven by the need to enhance energy security, combat climate change, reduce dependence on fossil fuels, and meet the growing cleaner energy demands. The envisioned green growth presents an opportunity to generate significant employment opportunities for a large population. Skilling programmes are essential to address the skills gap and ensure a smooth and successful energy transition. Skilling initiatives can also address market challenges by fostering entrepreneurship and innovation. By nurturing a skilled workforce, India can foster the development of indigenous clean energy and climate positive solutions and technologies, reducing the reliance on imports, while promoting domestic industries and enterprises.

CHINA

[1.4]

1.4.1 CURRENT DEMOGRAPHICS

According to the data from the seventh national census, China's population in 2020 reached 1.41178 billion, accounting for approximately 18% of the world's total population, solidifying its position as the most populous country globally. Comparing this to the 2010 census data, which recorded a population of 1.33972 billion, there has been a growth of 5.38%, with an average annual growth rate of 0.53%. This signifies the continuation of the low growth trend observed over the past decade.

In terms of regional distribution, the population shares are as follows: the eastern region accounts for 39.93%, the central region for 25.83%, the western region for 27.12%, and the northeastern region for 6.98%. Compared to 2010, the population share of the eastern region has increased by 2.15%, while the central region has decreased by 0.79%. The western region has seen a slight increase of 0.22%, and the northeastern region has experienced a decline of 1.2%. Population migration remains active, with individuals gravitating toward economically developed regions, further reinforcing the agglomeration effect. In terms of gender composition, males account for 51.24% of the population, while females make up 48.76%. The gender ratio of the total population (the ratio of males to females, using females as 100) stands at 105.07, which is relatively consistent with the 2010 figures, albeit with a slight decrease. The gender ratio at birth has seen a positive change, decreasing by 6.8, down to 111.3 compared to 2010, indicating an improvement in the gender structure.

However, the census data also reveal certain structural contradictions in China's population. These include the shrinking size of the working-age population and women of childbearing age, the deepening aging phenomenon, the decline in the total fertility rate, and the low number of births. Nevertheless, China's population still exceeds 1.4 billion, ensuring long-term advantages in terms of population size and a large market. With a working-age population of nearly 900 million, the country still possesses abundant labour resources. Furthermore, the data indicates that by 2022, the working-age population aged 16-59 will have an average of 10.93 years of education, representing an increase of 0.11 years compared to 2021 and 0.18 years compared to 2020. This continual improvement in the quality of the population will strongly support the transformation of the economic development model, the upgrading of the industrial structure, and the enhancement of total factor productivity. It will also contribute to the sustainable, coordinated, and healthy development of both the population and the economy and society as a whole.

1.4.2 CURRENT STATE AND DEVELOPMENT TRENDS IN ENERGY EDUCATION IN THE ENERGY TRANSITION

China, as a significant participant, contributor, and leader in global energy governance, plays a pivotal role in promoting the energy transition. The profound socio-economic changes brought about by this transition have raised higher expectations for energy education among China's youth. The construction of a new energy system that is clean, low-carbon, safe, and efficient necessitates a skilled workforce equipped with a global perspective, comprehensive knowledge, interdisciplinary expertise in industry and management, and other essential competencies. The following specific requirements have emerged:

Firstly, there is a need to upgrade the skill sets of workers in the traditional energy sector to align with the clean and intelligent energy system. As energy security remains crucial during the transition, it is essential to provide training for the workforce in the traditional energy industry. Nonetheless, the advancement of the energy transition, coupled with continuous progress in science and technology, demands a shift in the training paradigm for talent in the traditional energy sector. Training programs should harness the potential of low-carbon and intelligent technologies to facilitate the decarbonization, optimization, and integrated management of energy systems. Urgent upgrades in talent training are required to align with the transition towards the clean and efficient use of energy. There is a need to enhance skills training for clean and intelligent energy production. Focused efforts should be directed towards addressing talent gaps related to intelligent technologies in the optimal power system dispatching and CCUS. Similarly, talent development should address challenges related to CCUS technologies in the decarbonization transition of the fossil energy industry.

Talent training for the new energy industry must align with high demand and specialization. The energy transition has significantly increased the demand for talent in fields related to the development of efficient, reliable, and cost-effective new energy technologies. While the growth of low-carbon technologies like solar and wind energy can create a net increase in employment opportunities compared to traditional energy sources, the transition process may also lead to structural unemployment due to a skill mismatch. To address this, higher education institutions need to expand the development of courses focused on new energy technologies, ranging from solar photovoltaic cell development to wind turbine design, from biomass energy utilization to energy storage technology advancement. These courses require dedicated research teams to promote technological innovation and breakthroughs.

Furthermore, the energy transition requires global governance talent with a diverse background. It is a global challenge that demands international solutions and management professionals with a broad international perspective. Particularly in international contexts such as emergency situations or geopolitical conflicts, the energy transition becomes even more complex and challenging. Risks associated with technology, policies, markets, and resource supply may be further heightened. Therefore, there is an urgent need for young talents to engage on a higher and broader international stage, contributing to China's efforts in promoting changes in the global governance system and initiating international cooperation. Moreover, the energy transition has created a pressing demand for multidisciplinary experts in carbon markets, carbon management, carbon accounting, and carbon auditing. Professionals with an interdisciplinary background and comprehensive skills can provide professional carbon management and reduction solutions for countries, regions, or enterprises. Their expertise is vital for jointly achieving the climate change mitigation and high-quality socio-economic development.

To address the needs above, China is actively cultivating high-quality talents for energy transition. As the nurturing ground for young talents and a leading force in innovation and entrepreneurship within China, universities bear a significant and distinctive responsibility and mission in the implementation and advancement of the energy transition strategy. In July 2021, the Ministry of Education issued the ***Action Plan for Carbon Neutral Science and Technology Innovation in Higher Education***. The Action Plan explicitly outlines the pivotal responsibilities of universities in providing scientific and technological support, as well as talent cultivation, to achieve the dual carbon goals. It emphasizes the continual adjustment of the structure of carbon-neutral-related majors and disciplines, enhancing the caliber of talent training, and optimizing the talent training system. These measures aim to position China at the forefront of establishing world-class carbon-neutral universities and disciplines. In May 2022, the Ministry of Education further solidified its commitment by issuing the ***Work Plan for Strengthening the Construction of Carbon Peaking and Carbon Neutrality Higher Education Talent Training System***. This Work Plan calls for expediting the development of majors focused on energy storage and hydrogen energy. Additionally, it emphasizes the accelerated training of professionals specializing in CCUS. The Work Plan also highlights the expansion of teaching resources, such as curricula and teaching materials, in the field of carbon peaking and carbon neutrality. Furthermore, the creation of a high-level science and technology public platform is envisioned. Encouraging the cultivation of interdisciplinary talents, introducing strategic emerging majors, and emphasizing research on low-carbon technologies have emerged as key focal points for talent development within the energy sector.

Best Practices in China's Energy Sector (Education Sector)

Several universities have taken proactive measures to implement the national talent training strategy by focusing on professional development, curriculum design, event organization, international cooperation, and university-enterprise partnerships. China University of Petroleum (Beijing) serves as an exemplary institution in this regard. Having identified the latest trend of green and low-carbon development and new requirements of changing the knowledge production, the university has actively optimized its discipline structure and settings. The university has taken a pioneering role in establishing key schools, including the School of Carbon Neutral Future Technology, the School of Carbon Neutral Demonstration Energy, and the School of Digital Intelligence Oil and Gas Modern Industry. Moreover, the university has introduced multidisciplinary majors such as Energy Storage Science and Engineering, New Energy Science and Engineering, and Energy Economics. These initiatives aim to create a model platform for energy technology innovation and talent training. The university endeavors to nurture cross-disciplinary innovators who can address the forefront challenges in the energy field. Additionally, it plays a vital role in disseminating the concept of energy transition, meeting the demand for talent training proposed in national strategic initiatives, and promoting the low-carbon and intelligent transition of the energy industry.

The university has also developed a range of new cross-disciplinary courses, including climate change economics, big data accounting, and carbon accounting, as part of its curriculum expansion. By combining practical teaching with scientific collaboration, students actively engage in real-world projects and research investigations, fostering their innovative thinking. Through the establishment of a curriculum system focused on energy transition, the university cultivates well-rounded individuals with comprehensive skills and practical abilities. These efforts provide intellectual support for a successful energy transition.

Furthermore, the university actively fosters teaching and research through various competitions, aiming to identify and select young talents who possess a keen interest in energy transition and innovative ideas for entrepreneurship in the energy sector. For instance, the inaugural China Youth Carbon Neutral Innovation and Entrepreneurship Competition, a collaborative effort between the university, enterprises, and institutions, was organized to implement the significant strategic decisions of the Party Central Committee and the State Council regarding carbon neutrality. The competition seeks to further reinforce the talent-centric strategy in the new era, harness the innovative energy of today's youth, and enhance the sense of responsibility among Chinese youth who are encouraged to contribute to achieving carbon neutrality.

Regarding international cooperation, China University of Petroleum (Beijing) was designated as the UNESCO Chair in Carbon Neutral and Climate Change Driven Green Transition in late 2022. This prestigious chairmanship, the world's first directly related to carbon neutrality, facilitates global sharing of green and low-carbon technologies and knowledge through digitalization and intelligence. It promotes the advancement of open science and contributes Chinese perspectives and wisdom to the low-carbon energy transition.

Regarding university-industry collaboration, the university plays a crucial role in providing professional training and knowledge transfer to assist enterprises in understanding and addressing the challenges of energy transition. Simultaneously, enterprises offer practical internship opportunities to students, actively participate in the development of customized training programs, and provide targeted developmental prospects to explore their unique models for talent cultivation. The synergy between the university and enterprises enables the harnessing of complementary strengths and the cultivation of highly competitive and adaptable talent for the energy transition.

As China takes decisive steps towards the energy transition, it recognizes the pressing issue of a significant talent shortage in fields closely related to the transition, as well as the imbalanced structure of available talent. To address these challenges, China is committed to gaining a comprehensive understanding of the objectives and tasks of the energy transition from a strategic standpoint, and steadfastly implementing a talent-centric energy transition strategy. To ensure success, specific measures have been identified in the following five key areas:

Firstly, there is an active emphasis on holistic planning and the implementation of the strategy to strengthen the nation through talent. In alignment with the "Double First-class" initiative, the concerted development of "Double First-class" construction and the double carbon goals is prioritized. Universities are encouraged to fully leverage their role as productive forces in scientific and technological innovation, cultivating talents as a primary objective and ultimately enhancing the overall innovative capacity of the nation. By playing a crucial role in talent development for the energy transition, universities actively contribute to improving the quality of talent training, fostering innovative individuals who meet the nation's needs, and establishing a robust foundation for achieving the dual carbon goals.

Secondly, it is essential for China to dismantle the barriers of specialization and enhance the integration of relevant disciplines. In line with the "Double First-class" initiative, the establishment of interdisciplinary teaching teams in the field of energy transition is in need. Interactions and collaborations among diverse disciplines embodied in the share of resource, information and platform sharing are also encouraged. Meanwhile, universities should align with the latest domestic and international research frontiers and national policies. The innovation capabilities of postgraduate students in the energy transition field should be bolstered as well. Moreover, universities should consolidate the resources of various professional fields within universities and foster interdisciplinary collaboration and international exchange, thereby forging scientific and technological innovation advantages.

Thirdly, there is a need to promote the integration of concepts and accelerate the incorporation of energy transition into the education system. Utilizing the existing framework of professional construction, a postgraduate training system capable of integrating the concept of energy transition should be established. This entails enhancing the development of professional courses and providing guidance for postgraduate studies in alignment with energy transition objectives. Leveraging the educational advantages afforded by the digital economy era, postgraduates should be encouraged to tap into public online lecture resources from esteemed universities which allow students to gain insights from experts and scholars in respective fields.

Additionally, it is crucial to facilitate access to diverse channels of information concerning policy changes and industry dynamics related to energy transition. This helps stimulate the internal drive of postgraduates to engage in research within the relevant field. Special attention should be given to the practices relevant to energy transition during the postgraduate education stage. It is crucial to construct laboratories for practical courses to improve the ability of postgraduate students to combine theory and practice. Through a comprehensive design, a mature, replicable, sustainable, and practical postgraduate training curriculum can be established. This will contribute to the development of an education system framework that enhances students' innovation capabilities in the field of energy transition during their postgraduate education. Furthermore, it will drive the advancement of higher education developed under the "Double First-class" initiative, rendering the development featured of Chinese characteristics, integrated development, and global competitiveness.

Fourthly, it is crucial to strengthen the integration of industry and education, thereby fostering a new momentum for entrepreneurship. To cultivate versatile, practical, and innovative talents in the field of energy transition, the university should adopt a multi-faceted approach to innovate the training mode. This includes establishing partnerships with enterprises and jointly formulating comprehensive training plans that integrate teaching with industry practices. By doing so, students can apply the theories they have learned in practical settings, thereby enhancing the effectiveness of practical teaching in energy-related majors. Moreover, innovative research activities focused on energy transition should actively involve both undergraduate and postgraduate students. Industry or enterprise experts should be invited to campus to participate in the development of training programs, provide professional guidance, and offer educational resources to students. A mature assessment mechanism should be implemented to evaluate students' professional abilities in energy, environment, economics, and finance so as to effectively stimulate students' innovation.

Fifthly, there is a need to deepen international exchanges and facilitate joint training of energy transition talents. This involves establishing several innovation and intellectual attraction centers within universities dedicated to the field of energy transition. These centers should actively seek to attract and gather high-level overseas talents to contribute to the development of energy transition-related disciplines and scientific research in China. Support should be provided for talent cultivation in the field of carbon neutrality and facilitate academic and scientific research exchanges. Additionally, universities should be supported in organizing high-level international academic conferences or forums focused on energy transition. Proactive efforts should be made to strengthen international cooperation in addressing climate change, promoting the formulation of international rules and standards. Support should also be extended to the establishment of international scientific and technological cooperation and innovation platforms related to energy transition, enabling universities to participate in international scientific programs and projects within the energy transition field.

The **BRICS Youth Energy Summit** took place in September 2022, bringing together more than 20 distinguished guests from energy authorities of BRICS countries, relevant national ministries, oil companies, UNESCO agencies, as well as the embassies of the United Arab Emirates and South Africa. The event received tremendous support, with over 26,000 individuals tuning in online, making it a resounding success. Moreover, the "International Competition on Energy and Climate Change" held in conjunction with the Summit attracted participation from over 1,600 young individuals representing 68 universities across 31 countries. Their active involvement showcased the deep concern of young people for the future of humanity and the importance of green transition. Moreover, their enthusiasm for innovation and commitment to responsibility were evident throughout the competition, reflecting the unique spirit of the youth community.

Fossil Fuel Resource: Coal

2022 BRICS Energy Report: In 2020, China's coal production was about 3.9 billion tons. From 2015 to 2020, China's coal production decreased before going up, with the total output within 3.9 billion tons. In 2016, China decided to effectively resolve the excess capacity of the coal industry in 3-5 years by phasing out about 500 million tons of capacity and reducing and restructuring about 500 million tons. By the end of 2020, more than 1 billion tons of outdated coal production capacity had been phased out in China and the coal industry achieved the goal of high-quality transition and development.

Natural Gas

2022 BRICS Energy Report: In 2020, China's natural gas consumption was about 328 billion cubic meters, a YoY increase of 7.2%, which was lower than in previous years. To break it down by users, the industrial sector and urban utilities users each accounted for more than 1/3 of the total consumption in 2020, while gas for power generation and the chemical industry jointly accounted for nearly 1/3. The industrial sector and urban utilities were the main drivers of the growth of natural gas consumption. The newly added gas-powered vehicles in the transport sector were mainly commercial vehicles like LNG heavy-duty trucks.

Hydro Power

2022 BRICS Renewable Energy Report: China ranks first in the world in terms of exploitable hydro resources. According to the latest statistics, China has 690 GW of exploitable hydro resources that can generate about 3 trillion kWh of electricity annually. By the end of 2020, China had installed 330 GW of conventional hydropower capacity, mainly in the southwest, central, southern, eastern and northwest regions.

About 12 GW of conventional hydropower was put into production in 2020, significantly increasing from the 3.8 GW in 2019. By the end of 2020, China's large conventional hydropower plants under construction had a total installed capacity of about 48 GW, mainly in the southwest.

By the end of 2020, China's total hydropower capacity installed or being installed accounted for about 56% of that technically exploitable, with about 50% already installed and 7% being installed, and about 300 GW of hydro resources remaining to be developed.

By the end of 2020, the installed capacity of conventional hydropower in major river basins hit nearly 150 GW, accounting for about 45% of the country's total, of which more than 80% were in the areas with a high level of development along five rivers including Jinsha River and the upper reaches of the Yangtze River.

Nuclear Power Energy

2022 BRICS Energy Report: After more than 40 years of research, design, manufacturing, construction and operation, many breakthroughs have been made in China's nuclear power technology. Among them, the Hualong One is an important innovation of the third-generation pressurized water reactor technology with completely independent intellectual property. In November 2020, Unit 5 of Fuqing Nuclear Power Plant in Fujian, which was the world's first Hualong One reactor, was connected to the grid for the first time, setting a record for the shortest construction period for the first reactor of a third-generation nuclear power plant. In the same year, the first overseas Hualong One reactor, Unit 2 of Karachi Nuclear Power Plant in Pakistan, also completed its first fuel loading.

Renewable Energy

2022 BRICS Energy Report: China has a vast territory and is rich in renewable energy resources. Hydro resources that are technically recoverable in China hits 687 GW, with a power generation potential of about 300 TWh, ranking first in the world. In terms of wind power, the onshore and offshore wind resources in China that are technically recoverable are more than 10 TW, mainly in the southeast coast and nearby islands, northeast, north, and northwest. In terms of solar energy, China's annual total solar irradiance on the horizontal land surface averages about 5,360 MJ/m2. From northwest to southwest, the solar irradiance first increases, then decreases and then increases again. Taking into account factors such as regional distribution of solar resources, topography, technological development level and land conditions, China's photovoltaic (PV) power generation potential is 100-130 TW. In addition, China is rich in biomass resources, which mainly include agricultural waste, forestry waste, livestock and poultry manure, municipal solid waste, organic wastewater and waste residue. The total amount of biomass resources that can be used as energy every year is about 500 million TCE.

1.4.3 PLANNING HORIZON FOR THE ENERGY SECTOR

Energy Sector Development Policies: Planning and Goals

In October 2022, under the leadership of General Secretary Xi Jinping, the Party Central Committee of the People's Republic of China emphasized the imperative of promoting a comprehensive energy revolution and expediting the planning and construction of a new energy system. This directive provided a clear path for the high-quality development of China's energy and electricity sector in the new era.

In March 2022, China officially promulgated the **Plan for A modern Energy System During the 14th Five-Year Plan Period**, which set out the main objectives for the build of a modern energy system during the 14th five-year plan period as below:

- **Better energy security**. By 2025, the comprehensive domestic energy production capacity will reach more than 4.6 billion tons of standard coal annually. The annual production of crude oil will rebound and stabilize at the level of 200 million tons; the annual production of natural gas will reach more than 230 billion cubic meters, and the total installed capacity of power generation will reach about 3000 GW.
- **Remarkable achievements in the low-carbon energy transition**. The cumulative carbon dioxide emissions per unit of GDP in 5 years will drop by 18%. By 2025, the proportion of non-fossil energy consumption will increase to about 20%; the proportion of non-fossil energy generation will reach about 39%; the level of electrification will continue to rise, and the proportion of electrical energy to energy end use will reach about 30%.
- **Significantly higher efficiency of the energy system**. Energy-saving and consumption reduction efforts are effective, and energy consumption per unit of GDP will decrease by 13.5% in 5 years. By 2025, the proportion of flexibly regulated power sources will reach

about 24%, and the power response capability at the demand side will reach 3% to 5% of the maximum electricity consumption load.

- **Increased capacity for innovation-driven development**. During the 14th five-year plan period, it's estimated that the average annual investment in energy research and development will increase by more than 7%, and about 50 items of new key technology breakthroughs will be made.
- **Constantly improved service for the general public**. The per capita domestic electricity consumption will reach about 1,000 kWh, and the coverage of natural gas pipeline network will be further expanded.

Current State of Energy Sector Development: Total Amount, Structure, and Trends

China has made remarkable advancements in its energy industry, particularly in production support capacity, green and low-carbon transition, energy technology innovation, institutional mechanism reform, and international cooperation.

i. Steady improvement in energy production capacity: In 2021, China witnessed a 5.2% year-on-year growth in total primary energy consumption, reaching 5.24 billion tonnes of standard coal. Primary energy production increased by 6.3% year-on-year, reaching 4.33 billion tonnes of standard coal, marking a 10-year high growth rate. This total production comprised 4.13 billion tonnes of raw coal, 199 million tonnes of crude oil, 207.58 billion cubic meters of natural gas, and 2.73 trillion kilowatt hours of primary electricity generation.

ii. Accelerated green and low carbon energy transition: In 2021, China maintained its global leadership in wind and solar power generation, with respective installed capacity surpassing 300 GW. Coal consumption accounted for 56% of total energy consumption, marking a significant decline. The proportion of oil consumption decreased to 18.5%, while gas consumption increased to 8.9%. Non-fossil energy consumption reached 16.6%, and clean energy consumption reached 25.5%. Additionally, energy consumption intensity per unit of GDP reduced by 2.7%, and carbon emission intensity decreased by 3.8%.

iii. Thriving energy technology innovation and notable breakthroughs: Advancements in offshore wind power technology and advanced photovoltaic power generation technology exemplify the increasing level of energy technology. A package of significant innovative projects also made substantial progress.

iv. Robust progress in international cooperation within the energy sector and successful implementation of overseas energy projects: In China's future energy sector, there will be a clear shift from fossil energy being the primary source to becoming a supportive one. The future fossil energy technology evolution lies in the development of clean and safe fossil energy, along with promoting efficient and low-carbon utilization of fossil fuels. As part of the energy transition, the gradual replacement of fossil energy with non-fossil alternatives is expected. Renewable energy sources that offer high energy efficiency, cost-effectiveness, and system stability will continue to be the key development. Moreover, there will be a heightened emphasis on constructing a new power system centered around new energy sources. This system will be characterized by flexibility, openness, and advanced intelligence, evolving into an integrated energy internet system. Additionally, there will be ongoing advancements in carbon dioxide capture, utilization, and storage (CCUS) technologies, as well as the development of innovative energy storage solutions.

Emerging Areas in the Energy and Power Industry: Digital Intelligence, Multi-Energy Integration, and Their Potential Impact on Skills

The energy and power sector is undergoing a transformative phase, driven by profound technological advancements in energy production and consumption. These developments have not only elevated the industry's overall technical capabilities and operational efficiency but have also brought about significant shifts in the employment landscape within the energy and power sector.

i. **The specialization and compounding of the employment structure within the energy sector is a prevailing trend**. The advent of digitalization, intelligent systems, and other advancements in energy production have liberated the workforce from labour-intensive tasks. In today's labour market, there is a preference for employees who possess specialized skills, high productivity, and a keen awareness of accumulating knowledge and experience. The emergence of multi-disciplinary energy production and consumption methods, such as multi-energy integration, has made technical personnel with a diverse background increasingly common in the workplace.

ii. **The replacement of high-risk on-site manual work is on the horizon**. In the future, the widespread implementation of new intelligent system equipment and cutting-edge technologies like unmanned aircraft inspections will eliminate a significant portion of high-risk operations in the energy and power sector. On-site inspection patrols will ultimately be replaced by automation and intelligent technology.

iii. **Frictional unemployment will be superseded by technical unemployment**. On the one hand, the development of digital technology has reshaped the allocation of labour resources, making labour mobility more seamless and reducing frictional unemployment. On the other hand, repetitive and less technical jobs within the energy and power sector are prone to being replaced by digital and intelligent technologies, resulting in a rise in technical unemployment.

Development Trends and Momentum of Energy Employment in Energy Transition

In the face of climate change and the imperative for global energy transition, the development of renewable energy has taken center stage. Recognizing the urgency, China announced its commitment to achieving carbon peaking by 2030 and carbon neutrality by 2060 in September 2020. This declaration has fueled rapid growth and expansion within China's renewable energy sector. As the country focuses on deploying high-quality and large-scale renewable energy projects, the structure of the energy industry has undergone significant changes, consequently leading to a transformation in the required skill sets. While traditional energy sectors experience a decline in job demand due to the energy transition, new occupations and employment opportunities are emerging within the renewable energy sector.

In October 2021, China introduced the ***Action Plan to Reach the Carbon Peak by 2030***. This plan emphasizes the importance of a green and low-carbon energy transition while prioritizing safe carbon reduction. Ensuring energy security remains a paramount consideration when China actively promotes the adoption of renewable energy alternatives and accelerates the development of a clean, low-carbon, safe, and efficient energy system.

As the energy transition progresses, the demand for labour in the traditional energy sector is declining, resulting in a decrease in available job opportunities. To navigate this shift and the upgrade of the traditional energy industry, employees must continuously enhance their work skills by actively engaging in vocational training and ongoing learning, acquiring the knowledge and experience needed to thrive in the changing landscape. Conversely, the employment in the renewable energy sector is poised to experience significant growth, driven by favorable policies and market dynamics. However, rapid industry expansion and technical threshold for key positions may lead to an imbalance between supply and demand in the labour market. This means there might be a shortage of qualified "green personnel" to fulfill the increasing demand for "green positions." To address this challenge, it is crucial to promote labour training initiatives that enhance the skill level of employees, aligning them with the evolving needs of the industry.

To achieve the ambitious goals of "carbon peaking and carbon neutrality," China is set to accelerate its energy transition in the near future, with a specific focus on the following key areas:

i. **Firstly, China will continue to accelerate the development of new and renewable energy**. This includes promoting large-scale and high-quality advancements in wind and solar power generation. Additionally, hydropower development will be tailored to local conditions, and the active, safe, and orderly growth of nuclear power will be pursued. By 2025, it is projected that renewable energy generation capacity will account for over 50% of China's total installed power generation capacity.

ii. **Secondly, China will actively pursue the replacement and transformation of traditional energy consumption patterns**. Measures will be implemented to accelerate coal reduction, strictly and reasonably controlling coal consumption growth during the "14th Five-Year Plan" period, and gradually decreasing coal consumption during the subsequent "15th Five-Year Plan" period. China intends to implement rational regulations pertaining to the consumption of oil and gas. It aims to gradually adjust the scale of gasoline consumption while actively promoting the adoption of advanced bio-liquid fuels, sustainable aviation fuel, and other viable alternatives to conventional fuels. Simultaneously, efforts will be made to improve the energy efficiency of terminal fuel products.

iii. **Thirdly, China will expedite the construction of new power systems**. With energy and power security as a fundamental premise, the focus will be on developing a supply and consumption system with high shares of renewable energy. This entails optimizing the allocation of large-scale clean power resources and gradually increasing the proportion of renewables. By 2025, the installed capacity of renewable energy storage is expected to exceed 30 GW. By 2030, the installed capacity of pumped storage power stations is projected to reach approximately 120 GW.

Conclusion

China has made significant strides in its energy industry in recent years, bolstering its production capacity, expediting the green and low-carbon energy transition, achieving notable advancements in energy technology innovation, driving forward reforms in the electricity and oil and gas institutional mechanisms, and fostering deeper international cooperation in the energy sector. Looking ahead, China is poised to further advance the energy revolution and accelerate the planning and construction of a robust new energy system.

As China pursues the high-quality and large-scale development of renewable energy, the structure of the energy industry evolves, necessitating a shift in required skills. With the transition from conventional to renewable energy and the declining demand for jobs in the traditional energy sector, new occupations and employment opportunities are emerging within the renewable energy domain.

In order to establish a new energy system characterized by cleanliness, low-carbon emissions, safety, and efficiency, it is imperative to cultivate talents with a global perspective, a broad knowledge base, expertise in both industry and management, and a diverse range of competencies. These capable individuals will be crucial in supporting the energy transition.

SOUTH AFRICA

[1.5]

1.5.1 CURRENT DEMOGRAPHICS

The current population in South Africa is 50.6 million people. It is estimated that the population will grow to be 58.5 million people in 2030. Post 2030, further growth is anticipated, with the population estimated to be 73.2 million people by 2050. The demand for energy is expected to follow the same trends as population.

One of the biggest challenges currently facing South Africa is its high unemployment rate. At 32.9%, South Africa's unemployment rate is one of the highest in the world. This high unemployment rate is due to a number of factors, with one of the main ones being the economic downturn.

Responding to this high unemployment rate and the economic downturn, the South African government launched the New Growth Path (NGP). The target of this NGP was job creation, with an ambition to create, amongst other jobs, 300 000 jobs in the green economy. The NGP was built on two strategies. Firstly, it sought to deepen domestic and regional markets by 'growing employment, increasing incomes and other measures to improve equity and income distribution'. Secondly, it sought to widen the market for South African goods and services through 'a stronger focus on exports to the region and other rapidly growing economies. It identifies five jobs' levers to drive these measures: infrastructure, the development of main economic sectors, seizing the potential of new economic opportunities, investing in social capital and public services, and spatial development. The NGP also emphasised the necessity of skills development. Skills development is a particularly important theme in the country's energy transition.

South Africa has committed to keeping emissions to a range of 350-420 Mt CO2e by 2030. The South African cabinet has approved a goal to reduce greenhouse gas emissions to net zero by 2050. It is reported that the energy sector is responsible for about 80% of South Africa's GHG emissions. About half of this is from the production of electricity and liquid fuels. Given the energy sector's significant contribution to emissions, it is necessary for South Africa to transition this sector to cleaner and renewable fuels to achieve its climate-related targets.

To understand how to transition the energy sector, President Cyril Ramaphosa established the Presidential Climate Commission (PCC) with the purpose to oversee and facilitate a just and equitable transition towards a low-emissions and climate-resilient economy.

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

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

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

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

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

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

Table 6: Outcomes from the PCC's Work on the Just Energy Transition

Topic	Description
Electricity	**In the electricity sector, the priorities are to:** ■ Manage the decommissioning of the retiring coal generation fleet in tandem with the development of renewable energy generation at scale and pace; ■ Timeously strengthen the transmission grid infrastructure to accommodate the shift to renewable energy; and ■ To modernise the electricity distribution system.
New Energy Vehicles (NEVs)	**In the NEV sector, the priorities are to:** ■ Localise the NEV supply chain, setting the base for NEV manufacturing and component manufacturing; ■ Protect sector employment and promote new growth in sustainable manufacturing; ■ Incentivise investments in NEV-charging infrastructure; and ■ Convert public transport and private vehicles to NEVs.

Topic	Description
Green Hydrogen	**In the green hydrogen sector, the focus is to:** ■ Set South Africa up to become a world-leading exporter of green hydrogen by incubating local green hydrogen ecosystems; and ■ Undertaking critical planning, feasibility, and proofs of concept; and developing the necessary skills.
Skills development	Investment is needed to ensure that skills are in place to match the growth in new clean sectors and support worker transition.

The need to ensure that skills are in place to match the growth in new clean sectors and support worker transition is seen as one of the most crucial parts of the energy transition. Significant work, investment and collaboration is required to shift the current skillset of those working in South Africa's energy sector to a skillset needed to see the realisation of a clean and renewable energy sector.

1.5.2 NATIONAL EDUCATION SYSTEM

In South Africa, according to the Bill of Rights, the Constitution of the Republic of South Africa, Law 108 of 1996 states that 'the State is responsible for providing basic education to all local residents.'

South Africa has a unified national education system. At the State level, two ministries are responsible for education:

- The Department of Basic Education (DBE), which is responsible for primary and secondary schools.
- The Department of Higher Education and Training (DHET), which is responsible for higher education and vocational training.

We can further break South Africa's education system down into two main components:

- Basic Education:
  - General Education and Training (GET);
  - Further Education and Training (FET).
- Higher Education and Training (HET).

The main task of colleges is the professional training of school graduates for employment. The emphasis of these institutions is on vocational education and training of working specialties that meet the needs of the economy of South Africa. In total, there are more than 400 Technical and Vocational Education and Training (TVET) colleges registered in South Africa.

Community colleges are a new type of educational institutions. According to the 2013 White Paper on Post-Secondary Education and Training, these colleges are aimed at post-secondary young people and adults who want to build a base for further study, improve their skills for employment and/or gain training for further entry to TVET colleges or universities. Nine community colleges have been established, one in each province, which include 3 279 adult education and vocational training centres. Higher Education and Vocational Training (HET) include higher education, postgraduate studies, and doctoral studies. In 2019, there were 26 public universities and 131 private universities in South Africa, the total number of students exceeded 1.2 million people. All public universities are members of Universities South Africa. They are distributed across nine provinces of South Africa - each province has at least one university.

Table 7: Ranking of South Africa's Universities

	Times Higher Education (THE)	Quacquarelli Symonds (QS)	Shanghai Ranking's
1	University of Cape Town	University of Cape Town	University of Cape Town
2	Stellenbosch University	University of Johannesburg	University of Witwatersrand
3	University of the Witwatersrand	University of Witwatersrand	Stellenbosch University
4	University of KwaZulu-Natal	Stellenbosch University	University of Johannesburg
5	Durban University of Technology	University of Pretoria	University of Pretoria
6	University of Johannesburg	Rhodes University	University of Kwazulu-Natal
7	North-West University	University of Kwazulu-Natal	North-West University
8	University of the Western Cape	North-West University	University of South Africa
9	University of the Free State	University of the Western Cape	University of The Free State

In South Africa, many colleges and universities offer engineering courses with a focus on electrical infrastructure and electrical engineering, which includes energy-related topics. Some colleges have specialised programs specifically in the energy sector, such as Port Elizabeth TVET College, which offers a direction in the electrical infrastructure of renewable energy sources.

To encourage the inclusion of renewable energy and energy transition in curricula, the Department of Higher Education and Vocational Training launched the 'Colleges ecologization' program in 2013. This program is implemented in several colleges, including Boland TVET College, Central Johannesburg TVET College, Eastcape Midlands TVET College, Northlink TVET College, Northern Cape Rural TVET College, Port Elizabeth TVET College, and Umfolozi TVET College. Additionally, in 2022, an initiative was launched in the Western Cape Province to include 'Solar Photovoltaics (SPV)' in several TVET colleges. In 2022, the Ministry of Higher Education and Vocational Training, with support from the UK's Partnering for Accelerated Climate Transitions (UK PACT), introduced the 'Green Hydrogen TVET Ecosystem Just Transition Strategic Framework' program. This program aims to ensure that colleges teach the necessary skills for the development of South Africa's "green" hydrogen economy.

When analysing the curricula of Higher Education Institutions (HEIs) in South Africa, it was found that 14 of the largest internationally ranked HEIs offer energy-related study programs. These universities include the University of Cape Town, University of Stellenbosch, University of Pretoria, University of Johannesburg, Tshwane University of Technology, University of KwaZulu-Natal, Cape Peninsula University of Technology, Durban University of Technology, University of South Africa, University of the Witwatersrand, North-West University, University of the Western Cape, Rhodes University, and Nelson Mandela University. Although South Africa doesn't have specialised universities solely focused on energy, energy-related programs are offered within various faculties. The most common faculty related to the electric power industry is the Faculty of Engineering, which is available in all technological universities and leading traditional and comprehensive universities. Petrochemistry programs are mainly implemented in the faculties of Natural Sciences and Chemical Engineering, found in all technological universities and leading traditional and comprehensive universities. Nuclear energy education is primarily carried out in the "Physics" direction within faculties of natural sciences, with only one university having a specific nuclear engineering faculty.

South African universities also house research centres or research groups specialising in energy fields. For example, the University of Cape Town has the Energy Research Centre, while North-West University has numerous divisions, including the Centre of Excellence in Carbon-based Fuels and Hydrogen South Africa (HySA). The University of KwaZulu-Natal operates the Scientific and Technological Innovation Park (STIP) with research centres focused on smart grids and HVDC engineering. Moreover, South African universities often collabourate with schools and offer advanced training and professional retraining programs in the energy sector. The University of Stellenbosch's Centre for Renewable and Sustainable Energy Studies (CSIS) works with schools and provides short-term courses for the public and private sectors. Tshwane University of Technology implements a program to study solar and thermal energy in schools, and Durham University of Technology has the Energy Technology Station, which offers training courses in energy and water supply.

Overall, South Africa's colleges and universities are actively involved in equipping students with the necessary skills and knowledge for the energy transition, with a focus on renewable energy, energy efficiency, and sustainable development.

1.5.3 LABOUR MARKET ANALYSIS IN THE ENERGY SECTOR

Global and African

In 2019, it was estimated that 41 million people were employed globally in the energy sector, with an additional 24 million indirect employees involved in e.g. vehicle manufacture and energy efficiency. The figure below illustrates the global employment profile by energy sector in 2019. It indicates the main sectors of employment are end use vehicles (21%), oil and gas (18%), energy efficiency (17%) and power generation (17%).

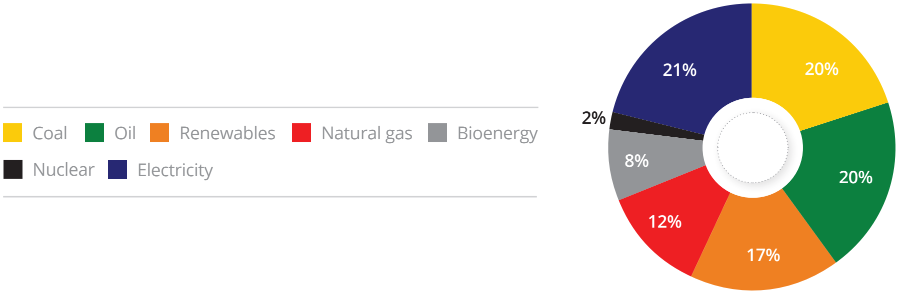


Figure 24: Global Energy Employment Profile, by Sector (2019).
Source: Derived from IEA (2022)

In comparison, Africa's energy sector employment profile illustrates some differences to the global profile (see the figure below). Most notably, is the dominance of the oil and gas sector as an employee (41% of total employed). However, in the sectors of energy efficiency and end of use vehicles, the continent employs significantly less than the global average. This indicates a focus on fossil fuel and power generation activities as the main employers, with fewer employees involved in clean energy. This is the reverse for Central and South America, Europe, China, India and Asia Pacific.

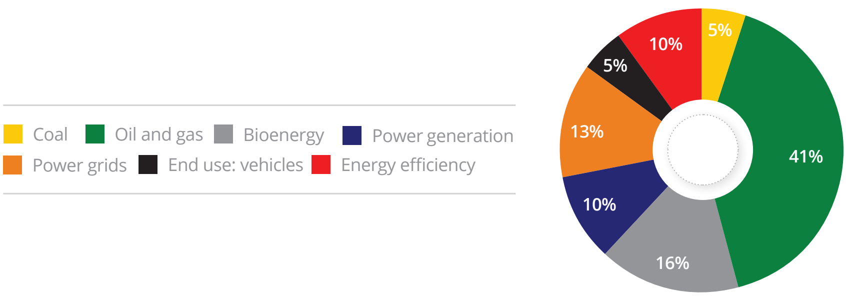


Figure 25: Africa Energy Employment Profile, by Sector (2019).
Source: Adapted from IEA, 2022

Regarding global renewable energy sector employment, an estimated 12.7 million people were employed directly and indirectly in 2021. Solar dominates employment numbers (34% of total employed), followed by liquid biofuels (19%), hydropower (19%) and wind energy (11%) (IRENA, 2022). In Africa, an estimated 320,000 people were employed in the sector in 2020, of which 23% were in southern Africa.

In terms of employment trends in the global energy sector, the IEA (2022) suggests that clean energy transitions and decarbonisation of energy are the predominant trends reshaping global energy employment. For example, it is estimated that 50% of total energy workers are employed in clean energy, which indicates the significant growth in this area. This is corroborated by IRENA (2022), who suggest employment in the renewable energy sector continues to grow and has grown by 10% since 2012. Most growth is in solar photovoltaics (PV), bioenergy, hydropower and wind power.

By 2030, this transition to clean energy is predicted to generate approximately 10.3 million new jobs (from 2021) globally, with energy efficiency, cars, power generation, grids, bioenergy and end-use renewables all gaining over 1 million new jobs. As a counterbalance, most job losses in this transition are going to be witnessed in coal and oil and gas, as fossil fuel demand decreases.

Other employment trends identified for 2022 include:

- 60% of the workforce is employed in construction of new projects e.g., building power plants, bringing oil wells online and laying pipelines, manufacturing cars, carrying out efficiency retrofits and installing efficient electric heat pumps.
- The need to transfer fossil fuels workers to low-carbon sectors and activities. With energy decarbonisation employment opportunities set to grow and outweigh the decline in fossil fuel jobs.

From a skills level perspective the IEA (2022) notes that the sector, in the main, requires higher-skilled workers, with jobs in research and development for new projects on the increase. Gender is also a core dimension of employment in the sector. The percentage of women employed is relatively low at 22%-25%, in comparison to other sectors. In sub-Saharan Africa women are estimated to comprise less (16%-20%) than the global average in the sector. Within the renewable energy sector, it is suggested that percentage is slightly higher, at 32%, and likely due to the more multidisciplinary nature of the sector.

South Africa Labour Market

According to the latest available energy balance from the South African Department of Mineral Resources and Energy (DMRE), South Africa's energy mix consists of coal, crude oil, nuclear, natural gas, geothermal and renewables. Coal contributed 65% towards the primary energy supply. The remainder was made up of crude oil which contributed 18%, renewables with 11%, natural gas with 3% and nuclear with 2%. The primary energy supply in this case includes local energy production and imports less exports.

Figure 26: Contributors to South Africa's Primary Energy Supply

According to the latest statistics from StatsSA, the following number of people are employed directly in the energy industry:

Table 8: Direct Employment in the Energy Industry Update statistics with StatsSA

Sector/Subsector	Number of People
Generation transmission and distribution of electricity	40 419
Manufacturing and distribution of gaseous fuels through mains	414
Total	**40 833**

In addition to the above, there are many people employed in the coal and petroleum sectors as tabulated below:

Table 9: Direct Employment in the Coal Mining and Petroleum Industries

Sector/Subsector	Number of People
Coal mining	93,000
Petroleum and gas	250,000
Total	**343,000**

Although direct employment is 40 883, there are many more people who are either employed in the energy value chain or supported by those employed in the energy industry and its value chain.

With the move towards cleaner sources of energy, it is important that those currently operating in the energy industry are reskilled to work within the renewable energy value chain or other sectors expected to expand in the energy transition.

1.5.4 THE MAIN CHALLENGES IN THE FIELD OF PERSONNEL TRAINING FOR THE FUEL AND ENERGY COMPLEX

Skills Required for the Current Energy Sector

Based on the list of occupations in high demand 2020 prepared by DHET, the most demanded professions related to the energy sector are:

- Construction managers
- Chemists
- Chemical engineers
- Mining engineers, metallurgists, and related professionals
- Electronics engineers
- Chemical and physical science technicians
- Electrical engineering technicians
- Power production plant operators
- Electrical mechanics and fitters
- Electrical line installers and repairers

Based on the Finalisation of the Critical Skills List. Technical Report 2022, prepared by DHET, DHA, DPRU, a list of professions containing the “most important” skills for the development of South Africa was formed. Of the identified professions, the following affect the energy sector indirectly or directly:

Table 10: List of Identified Professions Which Affect the Energy Sector Directly or Indirectly

Engineering Manager	Mining Engineer
Environmental Manager	Electrical Engineering Technologist
Climate Change Scientist	Energy Engineer
Geologist	Energy Engineering Technologist
Geophysicist	Organizational Risk Manager
Materials Scientist	ICT Systems Analyst
Hydrologist	Data Scientist
Environmental Scientist	Software Developer
Industrial Engineer	Chemistry Technician
Industrial Engineering Technologist	Electronic Engineering Technician
Mechanical Engineer	Mechanical Engineering Technician
Mechanical Engineering Technologist	Pressure Equipment Inspector
Chemical Engineer	Chemical Engineering Technician
Chemical Engineering Technologist	Transportation Electrician

In addition to DHET, EWSETA is engaged in the analysis of the labour market and the most in-demand skills in South Africa. According to the research of this organization, a list of key skills in the field of energy:

- Electrical Engineer
- Environmental Scientist
- Environmental Engineer
- Engineering Manager
- Program or Project Administrators
- Civil Engineering Technologist
- Mechanical Engineer
- Maintenance Planner

Skills Required for the Energy Transition

The following observations have been made with regards to jobs in the energy transition:

- Fossil-fuel-related jobs will decrease between 2023 and 2030, necessitating careful planning for skilling, reskilling, and upskilling to mitigate job losses.
- As the shift towards renewable and clean energy progresses, there will be high demand for design, construction, and installation-related jobs initially. This will be followed by an increased need for operations, maintenance, and evaluation jobs to manage and maintain the installed infrastructure effectively.

- Policy-related jobs, including policy development, management, and implementation, as well as research, analysis, and topic specialization, will be critical in the short term. Integrated policy and policy implementation are key considerations, requiring skilled individuals with technical, relational, and transformational competencies.
- Financial and governance-related jobs will play a crucial role in the short term, as the sector requires financial support and investment for the transition. Upskilling and reskilling current finance employees with sustainability knowledge is important, along with ethical governance practices.
- The decentralization of the energy system will shift responsibilities to district and local municipalities, impacting their workforce. Upskilling and employing more energy-related staff within local governments will be necessary, requiring human resource practitioners to understand the new job demands and skills requirements.
- The transformative energy sector requires a broader range of jobs beyond the technical and economic aspects. Social scientists, such as anthropologists, sociologists, gender specialists, community development coordinators, environmental education specialists, social workers, and trade union officials, will have an increasing role, particularly in dealing with affected communities.
- Post-school educators, including universities, TVET colleges, community colleges, and work-based educators, need to be knowledgeable and capable of providing suitable education and training for the current workforce or new graduates entering fields with growing job demand.

For South Africa to undergo an energy transition, various professional and technical skills are required. Here are some key skills that would be beneficial:

- **Renewable Energy Technologies:** Professionals skilled in the design, installation, and maintenance of renewable energy systems such as solar photovoltaic (PV), wind turbines, biomass, and hydropower are essential. They should have a solid understanding of the technical aspects, system integration, and grid connection of these technologies.
- **Energy Management and Efficiency:** Experts in energy management and efficiency can identify energy-saving opportunities, conduct energy audits, and develop strategies to optimize energy consumption. They should possess knowledge of energy-efficient technologies, building design, and industrial processes.
- **Electrical Engineering:** Skilled electrical engineers are vital to oversee the integration of renewable energy into the existing power grid. They should have expertise in power systems, transmission, distribution, and grid stability. Knowledge of smart grids, energy storage systems, and microgrid technologies is also beneficial.

- **Policy and Regulation:** Professionals well-versed in energy policy and regulations can play a crucial role in shaping the legal framework and incentives for renewable energy deployment. They should have knowledge of international best practices, renewable energy targets, feed-in tariffs, and net metering policies.

- **Project Management:** Effective project management skills are essential for overseeing large-scale renewable energy projects. Professionals with expertise in project planning, risk management, procurement, and stakeholder engagement can ensure the successful implementation of energy transition initiatives.

- **Research and Development:** South Africa needs experts in research and development (R&D) to drive innovation in renewable energy technologies and find solutions to overcome technical and economic challenges. These professionals can conduct studies, develop prototypes, and contribute to the advancement of clean energy technologies.

- **Data Analytics and Digitalization:** The ability to collect, analyze, and interpret energy data is becoming increasingly important. Professionals skilled in data analytics, machine learning, and artificial intelligence can provide insights for optimizing energy systems, predicting demand patterns, and improving operational efficiency.

- **Environmental and Sustainability Expertise:** Given the focus on clean energy and sustainability, professionals knowledgeable in environmental impact assessment, ecological management, and sustainable development can help ensure that energy transition efforts align with environmental and social goals.

- **Skills Development and Education:** Building a skilled workforce is crucial for a successful energy transition. Professionals experienced in vocational training, curriculum development, and capacity building programs can help train and educate individuals in the required technical skills for the renewable energy sector.

- **Collaboration and Communication:** Effective collaboration and communication skills are essential to engage stakeholders, build partnerships, and advocate for the energy transition. Professionals who can bridge the gap between technical knowledge and public awareness can facilitate a smoother transition process.

Building the Required Skills

To build the required skills as outlined above, it is crucial to focus on skills development and education. The following recommendations with respect to skills are outlined in the Just Transition Framework:

- **Reskilling and upskilling existing adult workers:** Provide training and learning opportunities for workers in both formal and informal sectors. This includes facilitating career transitions based on existing education and skills, recognizing prior learning, and overcoming barriers to skills development in the informal sector. Active labour market policies should be implemented to assist individuals in redefining job goals, preparing for new opportunities, and supporting relocation as industries evolve.
- **Building skills for green jobs:** Align the skills development system with the anticipated labour force needs of the future, particularly in green jobs that support a just transition. Strengthen mechanisms for identifying future skills requirements, invest in skills development capacity, and establish new occupational standards, curricula, and training programs. Emphasise skills in labour-intensive green industries such as renewable energy, battery manufacturing, electric vehicles, and climate-proofing infrastructure.
- **Improving foundational skills:** Ensure that the basic education system delivers quality foundational literacy and numeracy skills necessary for livelihood adaptation. Enhance the responsiveness of the education system to changing skill demands, engage employers in post-secondary education, and encourage higher education institutions to focus on climate-related disciplines. Expand pathways to skills acquisition, including workplace-based training and apprenticeship opportunities. Strengthen the resilience and adaptive capacity of the education system, particularly in terms of safe learning environments and disaster preparedness.

Skills planning and anticipation are crucial and should be integrated into discussions early on, rather than added as an afterthought. Skills planning should consider long-term employment impact, recognise jobs and skills along the expanded value chain and time horizon, acknowledge geographical impacts, involve different actor groups, and provide transparent disclosure of employment numbers using standardized metrics.

Overall, a comprehensive approach to skills planning is essential to meet the demands of the energy sector's transition and ensure a well-prepared workforce. South Africa's higher education system is seen to be critical to achieving the above skills.

1.5.5 PLANNING HORIZON FOR THE SKILLS TRANSITION

This trend is a critical aspect in the South African context as it refers to not only energy as a driver of the economy and energy affordability, but also the distribution of income across a population as measured by the Gini coefficient. In 2021, South Africa had the highest inequality in the world, emphasising the need for an equitable, just and sustainable energy transition (Stats SA, 2018). This trend therefore shows a major tension between energy costs and a variety of socio-economic issues, despite declining renewable energy technology costs. It means that innovation around how to make energy access more affordable to low-income groups will be essential (Sarkodie and Adams, 2020).

Energy Prices

Energy prices are impacted by various factors out of the control of any one country in most cases. These factors may include:

- Global energy prices
- Declining technology costs for some technologies e.g., renewables
- Geopolitical shifts
- Operational costs

What is impacted? The widening energy gap has an impact on a broad range of issues including, but not limited to:

- Investor confidence
- Economic growth
- Affordability
- The 'justness' of the energy transition
- Widening gap between 'haves' and the 'have nots' (disenfranchised), leading to social ills
- The incentive to adopt energy efficiency practices

In order to slow and ultimately decrease this gap both government and public sectors as well as energy consumers will need to play a role:

- Promotion of energy efficiency, particularly in poor communities
- Government to incentivise and subsidise where appropriate
- Enabling private sector / prosumers to enable resale of excess energy
- Localisation where competitive
- Investigation of alternative fuels (incuding green fuels)

Energy Security

Given the importance of energy in economic growth this trend is of particular concern as it has knock-on implications that are significant for future growth and development and decarbonisation efforts. From an electricity point of view this has been declining since 2008 and for oil has been impacted by recent decisions around refineries in the country (Eskom 2022, SANEA 2022).

Short term energy security can be impacted by:

- Lack of finance and skills
- Poor maintenance or inadequate/bad quality maintenance
- Lack of planning
- Poor governance
- Human behaviour

Long term energy security can be impacted by:

- Changes in technology and associated prices
- Changes in policy impacting on energy mix and timeous decision making
- Lack of energy planning
- Poor implementation of projects or technology roll-out

What is impacted? Both long- and short-term security impacts:

- Adequacy of infrastructure e.g., grid constraints or lack of available generation
- Economic growth
- Investor confidence
- Productivity
- Ability to meet net zero carbon commitments
- Affordability
- Rise of prosumerism

The actions required to address this trend will require extensive actions over an extended period including:

- Adequate and adaptive planning
- Enabling policy
- Accessing adequate financing

- Focus on implementation
- Quality and timely maintenance
- Management of sabotage
- Strengthening and expanding the electricity grid and to make it specific, measurable, achievable, relevant, and time-bound (SMART) including a shift away from physical networks to smaller standalone networks

Climate Change

Achieving net-zero carbon emissions by 2050 is a global objective (UN, 2023). Each country in their Nationally Determined Contributions (NDC's) detail what they think they can achieve and by when. South Africa provided an update of this at COP 26 where it was highlighted that South Africa would need financial and technological support to reach net zero, as well as adaptation measures.

Whether or not South Africa is able to reach net zero carbon emissions by 2050, is impacted by a number of factors including, but not limited to:

- Local energy consumption patterns
- Implementation of energy efficiency and demand side management initiatives
- The electricity mix (renewables, storage, gas, nuclear, coal)
- Green hydrogen and PtX production or importation
- Financial support such as grants and concessional financing etc.
- The degree of electrification of the economy
- Economic growth and reindustrialisation

This trend has a wide-ranging impact on the entire country and every sector, but particularly the energy sector. Some of the impacts include:

- Cost of energy and therefore the cost of doing business, and energy affordability
- South Africa's competitiveness in global markets
- The need for supporting infrastructure e.g., ports and pipeline

The actions required are identified in various policy documents and is predicated on the support of developed countries, particularly funding and technology transfer:

- Decisions on the pathway for a transition to cleaner fuels, including the role of gas as a transition fuel
- This means updating the IRP and Integrated Energy Plans (IEP) that should be regularly updated every 2 years as a minimum

- Extension of the current IRP to 2050
- Integration of government policy, including incentives and taxes, trade issues, education, innovation systems and planning
- National funding plan for implementation of the Just Energy Transition Investment Plan
- Cost abatement curves

Dealing with Uncertainty in Skills Planning

The energy sector is being driven by several key trends both global and local. These have critical implications for skills development as not only will the current jobs be impacted, but new occupations and skills of the future must be determined.

Skills requirements for the energy system necessitates an ecosystem approach and acknowledge the transformative process that is occurring over time and local geographic areas. Siloed approaches need to therefore be avoided to maximise any opportunities and build any trade-offs into decision making.

The energy sector is in crisis and faces a great deal of uncertainty in developing a skills roadmap as a result. This means that flexibility and contingencies need to be built into any skills roadmap as well as continual tracking of the environment as uncertainties unfold.

1.5.6 INCORPORATION OF WOMEN AND YOUTH IN THE ENERGY SECTOR

With regards to gender, the majority of employees in the South African electricity and gas sectors are male, with 35% of women making up the electricity workforce, and 26% in the gas sector. This correlates with, although could be considered slightly higher than, the global average for women in the broader energy sector (22%-25%), and higher than the sub-Saharan energy sector (16%-20%). However, within the renewable energy and oil sectors, women make up as little as 10% of REIPPP projects (compared to the global average of 32% and less than 15% in the oil sector.

Leading energy companies in South Africa are implementing various measures to increase the role of women in this industry. To name a few, Eskom implemented the Eskom Women Advancement Program (EWAP), which received the UN Women's Empowerment Principles (WEPs) award as one of the best programmes for gender equality. In addition to EWAP, women's mentoring groups have been established within Eskom, and programmes are being implemented to promote women in management. Eskom also maintains detailed statistics on calculating the number of women employed or participating in training programmes. Women make up 34% of all Eskom employees, while their representation in the management level exceeds 50%. Exxaro implemented comprehensive measures to promote women in the mining industry. One of the main methods of Exxaro is compiling statistics on the number of women participating in training programmes: in 2021, 54% of scholarships were awarded to women studying engineering and mining disciplines at universities in South Africa, 51% of women were women in training and internship programmes. In 2021, Exxaro sponsored the training of 23 African women in TVET colleges to improve women's access to craft training.

Other initiatives include:

- Accelerated tracking and mentoring programmes for managers;
- Gender mainstreaming and raising awareness of sexual harassment at all levels;
- Encouraging and mentoring young women and girls in planning their careers and acquiring skills to become independent;
- Gender equality policy.

The representation of women in Exxaro at different levels of management ranges from 20% to 30%. For Petrosal, equal representation of women remains an unresolved issue, especially at the management level. As of 2020, women make up 30% of the total workforce. PetroSA also participates in the Technogirls program implemented by UNICEF in partnership with the Government of South Africa. Techno Girl is a South African program that supports girls interested in careers in mathematics, science, and technology. The program selects high school girls from disadvantaged communities to participate in mentoring, skill development seminars, and job search in the STEM field.

In addition to higher education, training is also seen as to be important in reskilling for the energy transition.

In 2012, Eskom founded the Eskom Power Plant Engineering Institute (EPPEI). The key objectives of the establishment of the institute include the training of highly qualified engineers, the creation of a stable platform for research, as well as the training of highly specialized technical specialists. Various specialized centers have been established at six leading universities (University of Cape Town, University of the Witwatersrand, North-West University, University of Pretoria, University of Kwa-Zulu-Natal, Stellenbosch University) in the following areas:

- Emission control
- Energy efficiency
- Combustion engineering
- Materials engineering
- Plant asset management
- High voltage engineering
- Renewable energy.

Exxaro Resources Limited has its own training programs, including the Professional-In-Training (PIT) Program, which provides comprehensive training courses for recently graduated engineers and graduates, preparing them for future roles within the company. This program offers specialized training in areas such as Human Resource Management, Finance Management, Information Management, and Industrial Engineering, among others. The PIT program includes technical coaching, leadership and management training, and assistance in finding employment upon completion. Foreign companies, such as Schneider Electric and TotalEnergies, also contribute to the training of specialists in the South African energy sector. Schneider Electric implements the Schneider Electric 2023 Scholarship Program, providing scholarships for bachelor's and postgraduate degrees in various fields, including Computer Science, Electrical Engineering, Industrial Engineering, and more. TotalEnergies, on the other hand, awards scholarships to financially disadvantaged young people pursuing full-time education at colleges or universities, and also partners with institutions like the University of the Witwatersrand for funding master's programs and offers on-the-job internship programs.

Shell, a British oil and gas company, supports education in South African schools and higher education institutions by providing programs in Science, Technology, Engineering, and Mathematics (STEM). They also offer scholarships for talented individuals seeking higher education and provide practical and theoretical training modules for young people. These initiatives by private energy companies aim to cultivate a skilled workforce, promote educational opportunities, and contribute to the overall growth and innovation in the energy sector of South Africa.

1.5.7 CASE STUDIES

CASE STUDY 1: SECTOR EDUCATION AND TRAINING AUTHORITY (SETA)

Introduction to the Organisation

SETAs are South African Sector Education and Training Authorities. These organizations were established by the Minister of Labour in 2005 to meet the skill development needs in many areas of the economy. For this purpose, the economy was divided into several sectors, each of which has its own SETA. As of 2022, there are 21 SETAs in South Africa.

SETA implements its programs to ensure interaction between the state, business and educational institutions. which is a unique example of a specially created organization for these purposes. Their main task is to implement the National Strategy for the Development of Skills and Skills of Employees in the Relevant Sector.

Roles and Responsibilities of the Organisation

Two SETAs are responsible for skills development in the energy sector:

- Energy and Water Sector Education and Training Authority (EWSETA) - in the energy and water sectors; and
- Mining and Minerals Sector Education and Training Authority (MqaSETA) - in the mining sector.

The main activities of EWSETA are to:

- Conduct studies to determine the demand for professional skills;
- Register and establish training programmes;
- Approve Workplace Development Plans (WSP) and Annual Training Reports (ATR);
- Fund of training programmes;
- Provide financial support for education.

The main activities of MqaSETA are to:

- Implement the mandate to provide quality assurance and align training programmes in the mining sector with the South African legal framework;
- Implement the objectives of the National Skills Development Plan (NSDP) for 2020-2030;
- Administer a number of skills development initiatives, including learning and training programmes and internships (MQA Internship South Africa, MQA Learnerships Program, MQA Skills Program for Artisan Aids and others);
- Facilitate access of the unemployed to vocational training programmes;
- Conduct research to determine the demand for skills;
- Support training initiatives within the mining community.

Activities Relating to Energy Transition Skills Development

EWSETA provides subsidies for training programmes. These subsidies are provided in accordance with the skills development priorities defined in the EWSETA sectoral skills development plan, which is reviewed annually. For example, EWSETA funds the Wind Energy Internship Program (WIIP). It also funded for the training of students specialising in nuclear power the first time. Funding is provided in the form of mandatory grants and discretionary grants. Mandatory grants are available to employers in the energy and water sector who contribute a skills development levy and who have received approval for their annual WSP and ATR are eligible for mandatory grant funding. Discretionary grants are available to skill development service providers.

EWSETA also collaborates with various other stakeholders. An example of EWSETA's collaboration with universities is a training centre at Durban University of Technology - DUT Energy Technology Station, which offers courses on solar thermal energy, photovoltaic systems, energy audit of buildings, water systems as well as energy awareness programmes.

In addition to funding and collaborating, EWSETA ensures the quality of qualifications that exist in the energy sector such as those qualifications relating to technological process operator of the hydropower plant, NPP, fossil fuel plants; the manager of operation of the electrical substation; energy efficiency specialist.

MqaSETA is focused on providing the sector with sufficient skills to improve the following areas: employment, health and safety, and productivity standards. Like the EWSETA, it also provides funding. Its activities are funded by the skills levy collected from employers in the mining and minerals sector by the South African Revenue Service (SARS). It disburses the funds back to the industry in the form of grants for providing training and supporting learners in special projects.

Examples of its Activities are:

- Its scholarship programme for which students of TVET colleges or undergraduate programmes at universities can apply. Priority is given to female candidates, students living in rural communities and students with financial difficulties.
- Its funding of the private company Starcrow 36 (Pty) Ltd. which provides license registration services.
- Its implementation of the Skills Programme for Artisan Aids (MQA) in association with Colliery Training College.
- Its participation in the pilot project Centres of Specialisation (CoS) DHET. The project involves the transformation of a number of TVET colleges into centres of specialization designed to train artisans in one or more of the priority professions, mainly engineering. The purpose of CoS is to simulate ways through which industry and employers can cooperate with public colleges and other relevant bodies to enhance the provision of professional qualifications in accordance with industry standards and economic needs.

CASE STUDY 2: ESKOM POWER PLANT ENGINEERING INSTITUTE (EPPEI)

Introduction to the Organisation

Eskom Power Plant Engineering Institute (EPPEI) is a partnership established in 2012 between Eskom and academia with the aim of developing technical skills and knowledge in the electric power industry and, more specifically, improving the skills of Eskom's engineering and technical staff. EPPEI is one of the best examples of a training system and a company's interaction with the national education system.

Roles and Responsibilities of the Organisation

EPPEI objectives are to:

- Solve Eskom's technical challenges, through conducting relevant research and improving the level of qualification of engineering and technical personnel.
- Develop technical competencies of Engineering Practitioners, Operators and Maintenance Practitioners, using short-courses and on-the-job, while at the same time advancing them to obtain CPD points, certificates, higher certificates, diplomas & registration.
- Build academic electricity research capacity at both Universities and Universities of Technology, in order to train Eskom and non-Eskom students in various specialization technical areas relevant to Eskom;
- Establish partnerships & collaborations with Independent Power Producers (IPPs), African Utilities, OEMs and Higher Learning Institutions to further develop electricity sector skills & competencies in order to contribute to the socio-economic development of South Africa and Africa;
- Contribute to localisation of power technologies, IP and local manufacturing in South Africa and African countries.

Activities Relating to Energy Transition Skills Development

There are 9 EPPEI Specialisation Centres in leading universities in South Africa, which pursue various areas, among them: Emission control, energy efficiency, combustion engineering, materials engineering, plant asset management, high voltage engineering and renewable energy.

The right to participate in an EPPEI Specialisation Centre is granted to persons holding bachelor's degrees in engineering or technical sciences and interested in obtaining master's degrees in similar fields. Applications from both people already working at Eskom and other candidates are considered.

CASE STUDY 3: ACCESS ENERGY SOLUTIONS

Introduction to the Organisation

Varsha Reddy is the founder of the renewable energy company Access Energy Solutions which operates in South Africa and Zambia.

Roles and Responsibilities of the Organisation

Access Energy Solutions redefines its customers' relationship with energy, saving money. It works to minimise its customers' carbon footprints and support energy security. It offers a selection of solutions for home and business, and Commercial Projects. Access Energy Solutions specializes in Sine wave Hybrid Inverters, Lead Acid, Maintenance Free Batteries, Tubular Batteries, Solar Pumps, Solar Panels, Solar Street Lights and Accessories.

Activities Relating to Energy Transition Skills Development

Varsha Reddy has been working on a project to create a unique educational course that aims to provide the necessary information about the renewable energy industry to women interested in starting their own business in this field or wishing to invest in renewable energy. At the moment, a training programme is being drawn up and contacts are being developed with educational institutions as potential partners of course implementation.

Varsha Reddy also provides technical training in her company. Access Energy Solutions employees regularly receive technical training aimed at increasing their knowledge in the company's key areas of work - solar power and solar panel installation, features of their use, disposal, repair, associated risks, the training also covers the changes in the industry.

Varsha Reddy has created a special channel for the expansion of links between women in energy and the formation of a community of renewable energy companies founded by women. The main objective is to increase the level of knowledge, confidence, and career opportunities of women in the energy industry and to promote business and entrepreneurial initiatives of women in the industry through increased collaboration among companies.

In the last two years, it has been possible to turn this communication channel into a full-fledged network, which includes several companies in renewable energy sector of South Africa: The Solar Power Café, Joule Energy Solutions, Sengan Solar, Sustainability Company, etc. Monthly meetings are held, during which topical issues of the sector are discussed: market trends, customer base issues, current and new challenges of the industry and possible solutions, options for finding financing or using state support, as well as the use of technical support.

CASE STUDY 4: THE PETROSA CENTRE OF EXCELLENCE (COE)

Introduction to the Organisation

The Petroleum Oil and Gas Corporation of South Africa (SOC) Limited (PetroSA) is the national oil company of South Africa and is registered as a commercial entity under South African law. PetroSA is a subsidiary of the Central Energy Fund (CEF), which is wholly owned by the State and reports to the Department of Energy.

The company holds a portfolio of assets that spans the petroleum value chain, with all operations run according to world-class safety and environmental standards. PetroSA was formed in 2002 upon the merger of Soekor E and P (Pty) Limited, Mossgas (Pty) Limited and parts of the Strategic Fuel Fund, another subsidiary of CEF.

Roles and Responsibilities of the Organisation

The PetroSA Centre of Excellence in Mossel Bay is responsible for recruiting and training the young people whose experience and expertise are essential to the future of its business and South Africa. Established in 2002, the Centre of Excellence was the first learning establishment dedicated to teaching the essential skills demanded by South Africa's petrochemical sector.

Activities Relating to Energy Transition Skills Development

Established in 2002, the COE was the first learning establishment dedicated to teaching the essential skills demanded by South Africa's petrochemical sector. Accredited by the Chemical Industry and Energy Training Authority (CHIETA), the COE provides learnerships and qualifications for chemical electricians, instrument mechanics, fitters, riggers, welders and boilermakers. These skills are seen as important for the energy transition.

PetroSA's COE is an accredited training provider and DTCC (Decentralised Trade Test Centre by the Chieta) in the petrochemical industry.

The COE has also been earmarked as one of the best producers of quality artisans in the petrochemical sector. By the start of 2012, 732 young learners had qualified through the COE. In addition, it has trained around 420 safety watchers, 258 mechanical operators and 504 floggers involved in the PetroSA refinery's statutory shutdowns. The centre's 99% success rate testifies to the professionalism of its staff, the quality of its courses and the standard of its facilities.

The COE value is gradually moving beyond PetroSA. By equipping youngsters with new skills and opportunities, for example, the centre is also helping to improve living standards among local communities. In line with the commitment to empowering women, 50% of learners at the centre are female. Around 70% of young learners are recruited from local communities, with the others recruited nationwide.

CHAPTER **2**

BRICS UNIVERSITIES, ENERGY COMPANIES SURVEY RESPONSE AND ANALYSIS

[2.1]

ENERGY TRANSITION SKILLS SURVEY AND ANALYSIS

BRICS countries play a crucial role in forming both the global energy mix (account for one-third of global energy production and consumption), and the global labour market (sharing half of global labour resources in the energy sector). Moreover, the five countries are leading in terms of number of workers employed both in traditional and renewable energy sectors.

For the coal sector the figure for BRICS countries is even higher and constitutes 80% of the global total. For renewables it stands at above 60%, for solar and wind generation - more than 50%; for hydropower – 65%; for energy efficiency – more than 50%. Three of the BRICS members are ranked among the top 10 countries in bioenergy generation labour force. These figures reveal, that on the one hand, the energy balance of BRICS is still based on the fossil energy sources (and according to the forecast of the BRICS Energy Research Cooperation Platform, their share in the energy balance in the next two decades would hold at more than 70% of total consumption), but on the other hand all the five countries support the achievement of the SDGs, and actively pursue economic transformation as part of their energy transition.

The trend towards just energy transition is affecting the energy balances of the BRICS countries. Its structure changes mainly through increase of renewables, nuclear power and phasing down of fossil fuels. Changes that occur with the process of just energy transition most certainly have an impact on the labour market in all five countries. In addition, according to the ILO study, most countries' efforts in energy transition and climate change adaptation are conducted through training of human resources and creation of jobs for professionals, directly engaged in these processes.

As labour market evolves, influenced by the energy transition, BRICS countries are facing the emergence of job demand for respective specializations. The International Renewable Energy Agency, for instance, predicts that the renewable energy sector alone will create more than

25 million new jobs in the labour market by 2030. At the same time, most of the existing professions are likely to be transformed, while some would disappear or be replaced. This would require maximum efforts on part of BRICS countries to ensure that negative socio-economic consequences are avoided.

The five BRICS members have different energy balances, as well as levels of access and availability of energy resources. Some are net exporters of energy resources, and some are net importers. In this regard, the need for training of specialists for the energy sector differs from country to country, depending on national specifications. At the same time, the study has shown that BRICS countries have a large number of similar challenges and difficulties in the areas of labour market development and training for the energy transition, which open up the potential for increased cooperation in respective area.

The study has revealed the following key factors in the labour market that tend to hinder energy transition within BRICS: aging of the working-age population, an increase in the average age of employees, problems with the transfer of experience to the younger generation, and lastly, the lack of specialists with necessary qualifications on the labour market.

The statistical data presented in the national parts of the study, as well as the survey involving more than 100 key energy companies and higher education institutions from the BRICS, confirm the fact that almost all the five countries face the problem of increased employees' average age. Considering the trends of population aging, as well as the fact that the energy industry mostly requires highly qualified specialists (this demand would only increase as the countries dive into the energy transition), in the near future all BRICS countries may face increased competition for professionals in the labour market, primarily within the IT sector.

Despite the fact that average salaries in the fuel and energy sector are generally higher than in other sectors of the economy (and that was once again proven by the survey), BRICS countries should consider making anticipatory efforts to increase the attractiveness of the industry for young professionals. This can be achieved through the deployment of career guidance activities, increase of social standards and introduction of human-centred principles into companies' operations.

Comparison of average wages in the companies of fuel and energy sector and average salary in the region of deployment

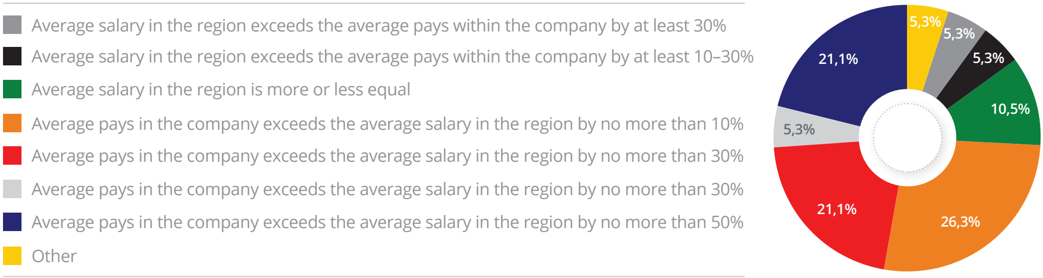


Figure 27: Survey Among Companies and Higher Education Institutes in BRICS Countries

To address the challenge of experience transfer from older to younger generations, BRICS companies actively use the mentoring mechanism, applying both group training and one-on-one mentoring methods (when a more experienced specialist works directly with the apprentice). In most companies, this mechanism has been in place for decades and has proven its effectiveness. When it comes to energy transition and the labour market, the second problem for the countries of the bloc is the shortage of specialists of the required qualification. The overwhelming majority of surveyed companies (about 90%) noted that they were in search of energy specialists, and that such specialists are in short supply. Among these are renewable energy experts, specialists in digital (automated) management of power facilities and specialist in the field of cybersecurity of power facilities.

In the context of energy transition, the existing gap between specialists required and available on the market may primarily be related to the difficulty of correlating and coordinating the needs of the state, businesses and the system of professional education to implement a unified policy on personnel training. During the survey, the majority of respondents noted the need to improve the mechanisms of interaction between the above-mentioned actors. Both companies and representatives of educational organizations believe that it is the state that should be the main driver of change in the field of personnel training in the context of energy transition.

The best and most notable systematic interaction in the field of personnel training is seen between educational organizations and business. The most common mechanisms of interaction between universities and companies in BRICS countries are joint training programs, participation in career guidance events held at universities, and organization of internships.

Partnership programs between HEIs and companies on professional education of energy specialists

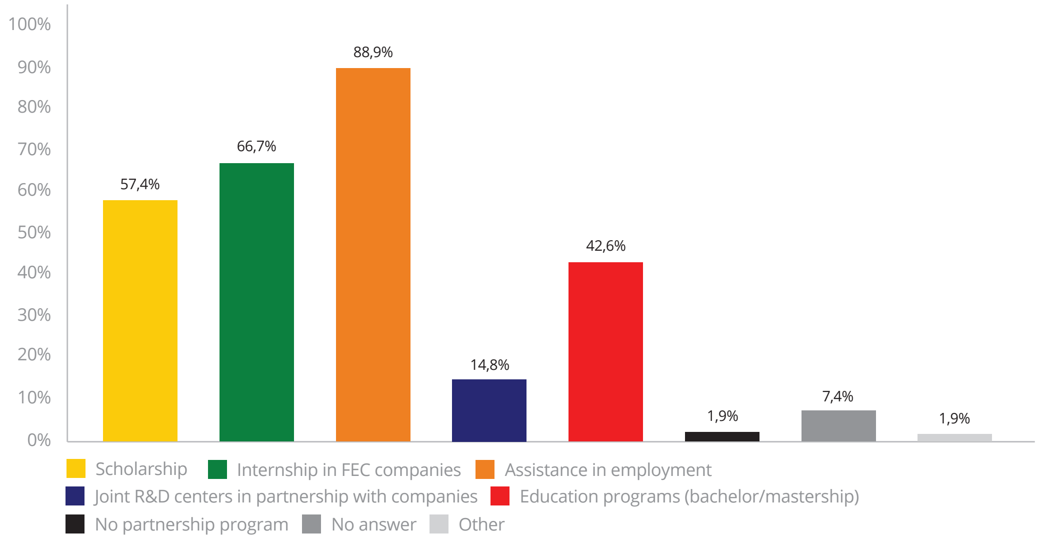


Figure 28: Survey for BRICS Companies and Higher Education Institutes

Most of the BRICS universities synchronize their curriculum with the national energy policy. In practice this results in the introduction of new university programs. These are launched in almost all of the surveyed countries on a fairly regular basis. Energy companies play a significant role in this process, as they also provide students with the opportunity to obtain practical skills in their field of study.

The shortage of specialists of the right qualification may also be related to the difficulty of timely determination of demand for skills and forecasting of staffing needs. That trend was revealed in all five countries. As energy markets evolve and the need for specialists of specific profile develops, the importance of collaboration between business, educational organizations and the government arises, in order to predict the most demanded professional specialization. Also, a stable energy policy pursued by the state, at least in the medium term, plays an important role for successful forecasting. For the same purpose, it is necessary to carry out systematic work to improve the collection of statistical data in the field of training and monitoring of fuel and energy sector labour market.

Another critical challenge with regards to labour market and energy transition facing BRICS countries is that certain professions phase out and numbers of employees critically drop down. Given the movement of all BRICS countries towards carbon, a certain number of labour resources in some countries are released (which in turn poses the need of their further integration into the fuel and energy sector through reskilling and upskilling). Based on this analysis, it is advisable to enhance cooperation between the BRICS countries on a whole range of areas related to labour market and professional education within the context of energy transition.

2.1.1 BEST PRACTICES

Each BRICS country has unique experiences and strategies in managing the labour market transition in the energy sector. Sharing these best practices can provide valuable information and lessons for all members. This can range from successful policies for retraining and reskilling the workforce, methods for managing job losses in traditional energy sectors, to innovative strategies for creating jobs in the renewable energy sector.

Sharing of best practices involves collaborative and multifaceted approaches that facilities effective knowledge exchange and learning. The following are key strategies that can be adopted and implemented to accelerate the sharing of information and skills across the BRICS countries:

- Strengthen Knowledge Sharing Platform: Through the BRICS Energy Research Cooperation Platform Create a dedicated platform or network for BRICS countries to share best practices, experiences, and success stories related to energy sector labour market development. This platform could include regular conferences, workshops, webinars, and online forums.
- Joint Research and Publications: Encourage collaborative research projects and joint publications on energy labour market development. This could involve academic institutions, think tanks, and research organizations from BRICS countries working together to analyse trends, challenges, and solutions.
- Data Sharing and Benchmarking: Strengthen the mechanism through the BRICS Energy Research Cooperation Platform for sharing data and conducting benchmarking exercises on energy workforce development indicators. This data-driven approach can identify areas for improvement and guide policy formulation.
- Multilateral Collaboration: Encourage cooperation and engagement with international organizations and initiatives focused on energy skills development. Participation in global forums and initiatives can provide exposure to innovative practices and global best practices.
- Technical Assistance and Support: Offer technical assistance and support to BRICS countries that may face challenges in developing their energy sector labour markets. This could involve sharing expertise, providing mentorship, and offering guidance based on successful experiences.

As part of the preparation of this study, with the coordinating role of the Republic of South Africa and with the support of all BRICS countries through their specialised agencies, the BRICS Energy Skills Informal Steering Committee Network was temporarily formed. The Steering Committee of the study included around 25 representatives from companies, universities and think tanks of BRICS countries (the list of the SC members will be attached to this report). The International Labor Organization (ILO) and the International Renewable Energy Agency (IRENA) actively participated in the preparation of the study.

More than 100 companies and universities took part in the survey, which was prepared to provide a more detailed study of the needs and challenges in the development labour market and educational system of the BRICS countries in the context of the energy transition. Experts from BRICS countries collected various cases demonstrating best practices in the field of personnel training both in universities and companies, interaction between business, government and the educational system, integration of women in the energy industry, and support for young professionals.

2.1.2 RESEARCH AND DEVELOPMENT INITIATIVES

Research and development can drive technological advancement in the energy sector, creating new job opportunities and stimulating the job market. Joint initiatives can focus on areas such as renewable energy technology, energy efficiency, grid infrastructure and energy storage. Collaborative research can accelerate technological development, reduce costs and contribute to the creation of highly skilled jobs in these sectors.

As of 2023 BRICS has established over 100 multilateral BRICS Research Projects under the BRICS Framework Programme, along with the BRICS Academic Forum, BRICS Think Tank Council, Network of BRICS Universities, and the virtual BRICS Vaccine Research and Development Centre. These platforms provide an opportunity for scholars, researchers, and academics from the BRICS nations to access intellectual exchange and collaboration on important issues, while navigating connections across dialogues and cultural exchange. The mentioned BRICS platforms can be detailed as below:

- BRICS Think Tank Council: The BRICS Think Tank Council is a cooperative mechanism that involves think tanks and research institutions from the BRICS countries. This council facilitates discussions and provides policy recommendations to the BRICS governments on issues ranging from economic development and trade to environmental sustainability and global governance. It serves as an important advisory body, contributing to evidence-based decision-making and fostering deeper understanding among BRICS nations.

- Network of BRICS Universities: The Network of BRICS Universities aims to enhance cooperation and collaboration among higher education institutions within the BRICS countries. This network promotes student and faculty exchanges, joint research projects, and academic partnerships. By facilitating the sharing of knowledge and resources, the network strengthens educational ties, fosters cultural understanding, and contributes to the development of skilled human resources within the BRICS bloc.
- BRICS Energy Research Cooperation Platform: The BRICS ERCP is promoting 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. 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.

2.1.3 REGIONAL INTEGRATION OF THE ENERGY LABOUR MARKET

The integration of regional labour markets can bring numerous benefits. It can facilitate the movement of skilled labour across borders, helping to fill skills shortages in specific areas and provide more opportunities for workers. It can also promote the standardization of qualifications and certifications, making it easier for workers to find jobs and for employers to find skilled labour. However, this would require careful coordination and policy alignment among BRICS countries.

Successful labour market development in the energy sector will be crucial for BRICS countries to achieve their energy transition goals. Cooperation in this area can help these countries face the transition more effectively, creating a sustainable and inclusive labour market that supports their economic growth and development.

2.1.4 EDUCATIONAL PROGRAMS AND RESEARCH INITIATIVES

Joint educational programs, spanning undergraduate, graduate and vocational degrees, can provide students with a comprehensive and diverse understanding of the global energy sector. Collaborative research initiatives can further promote innovation, contribute to the global body of knowledge in energy studies, and train future energy leaders and professionals.

For the purpose of fostering coordination between the government, business and HEIs in the area of professional education, BRICS countries could facilitate the conduct of independent evaluation and quality control for educational programs, conducted by the representatives of the respective industries. Stimulating solutions could also be designed for educational facilities to ensure independent evaluation and quality control for the programs launched on their basis.

2.1.5 EXCHANGE PROGRAMS FOR STUDENTS AND PROFESSORS

Exchange programs for students and professors offer a significant avenue for BRICS countries (Brazil, Russia, India, China, and South Africa) to enhance mutual understanding, academic excellence, and research collaboration. These programs enable valuable opportunities for cultural exchange, knowledge transfer, and professional development among member nations. By fostering academic ties and cross-border mobility, BRICS universities and research institutions leverage their collective strengths to address shared challenges and advance their positions in the global academic landscape. Moreover, these programs expose students and faculty to diverse energy scenarios, political environments, and technological advances, enriching learning experiences, providing new perspectives, and promoting international collaboration and understanding.

Exchange programs between BRICS countries offer several key opportunities for collaboration and academic growth. Firstly, they promote cultural exchange and mutual understanding by exposing students and professors to different cultural contexts and academic environments. Secondly, these programs foster academic excellence and innovation as participants gain access to diverse educational approaches and expertise from partner institutions. Research collaboration and knowledge transfer are also facilitated, empowering institutions to address common challenges with impactful solutions.

Language proficiency and communication skills are improved through language immersion, enabling participants to work effectively in multicultural settings. Additionally, exchange programs create valuable networking opportunities, leading to future collaborations and career prospects for students and professors. The diversity and inclusivity of academia are enhanced through these exchanges, enriching learning environments with a global perspective.

Moreover, joint degree programs may emerge as a result of exchange collaborations, allowing students to obtain degrees from multiple institutions and expanding their academic qualifications. Research publications and co-authored papers strengthen the global impact of BRICS institutions, elevating their reputation in the international academic community. Finally, these programs nurture future leaders who possess cross-cultural competencies and a global outlook, empowering them to address complex global challenges and contribute to sustainable development.

2.1.6 ENERGY EDUCATION CURRICULUM DEVELOPMENT

A significant step towards cooperation in energy education is the development of a jointly crafted energy education curriculum. Such an approach would ensure that students from all BRICS countries have access to high-quality, relevant, and up-to-date education aligned with the industry's needs. This collaborative effort can involve sharing and integrating best practices in pedagogy, incorporating emerging trends and technologies, and emphasizing skills that are in high demand in the energy sector. It is advisable to take into account the specialization of individual country in order to make the curriculum as effective and relevant as possible. Namely, Brazil has unique competencies in bioenergy, Russia – in the nuclear sector, power generation in remote areas, India and China – in solar and wind energy, South Africa – in synthetic fuels production. Educational courses could be focused on specializations that tend to be in demand as the five countries dive into the energy transition.

Collaborative energy curriculums are of paramount importance for several reasons. Firstly, they help bridge the gap between theoretical knowledge and practical application. By drawing on the expertise and experiences of multiple BRICS countries, the curriculum can offer a more comprehensive understanding of the energy industry's challenges and opportunities. It also exposes students to diverse perspectives, which fosters critical thinking and problem-solving skills essential in the complex energy landscape.

Secondly, a jointly developed energy education curriculum ensures that all BRICS countries can access high-quality and relevant education, regardless of their economic or educational background. This inclusivity is essential for building a skilled and diverse energy workforce that can drive innovation and sustainable practices across the bloc.

Thirdly, the collaborative curriculum allows for agility in addressing the fast-changing dynamics of the energy sector. By continuously sharing best practices and integrating emerging trends, BRICS nations can adapt their education systems to equip students with the latest skills demanded by the industry.

Specialisations in the Context of Energy Transition

The transition to sustainable resources and achieving net-zero carbon emissions is a global imperative to address climate change and ensure a sustainable future for generations to come. To effectively and continually perform in this endeavour, it is essential to develop specialized expertise in various fields that support the transformation of energy systems. The list above comprises critical specializations that are instrumental in this sustainable energy transition. The following are a compiled list of special fields which would be essential to ensure effective and continuing performance of sustainable resources and reaching net zero carbon emissions:

- Specialists in the field of digital (automated) control of power facilities
- Specialists in cybersecurity of power facilities
- Specialists in the construction highly automated networks
- Specialists in information modeling
- IT specialists with energy specialization
- Robotic systems engineers
- Specialists in nuclear power plants construction and operation
- Specialist in local power supply systems
- Microgeneration systems designers
- Energy storage designers
- Hydrogen energy engineers

Achieving sustainable resources and net-zero carbon emissions requires specialized expertise in various critical fields, including digital control of power facilities, cybersecurity, highly automated networks, information modelling, energy-focused IT, robotic systems engineering, nuclear power, local power supply, microgeneration systems, energy storage, and hydrogen energy. Collaboration among the BRICS countries on mutually agreed upon terms is of utmost importance, as each nation brings diverse expertise and resources to the table. By pooling their knowledge and research capabilities, BRICS nations can accelerate the development of sustainable energy technologies, optimize energy distribution, and improve grid resilience. Additionally, joint efforts in cybersecurity ensure the reliability and security of energy infrastructure, safeguarding against potential cyber threats.

BRICS countries have advanced technologies in the field of both conventional, low-carbon and carbon-free energy. However, according to the survey, only 1/3 of universities have operational demonstration centers, while more than 90% send students on internships to companies to gain practical experience. Establishment of a demonstration center will contribute to the practical training of specialists for the fuel and energy sector, as well as promote the development of interaction between universities and energy companies.

Collaboration further fosters research and innovation in areas that allow BRICS countries to harness low-carbon energy potential for a more sustainable energy mix. Moreover, shared expertise in local power supply systems and microgeneration enables decentralized energy solutions, reducing reliance on fossil fuels and increasing energy access in remote regions. By investing in research, infrastructure, and training programs tailored to these specializations, the BRICS bloc can strengthen its collective capabilities, enhance energy security, and make significant contributions to global efforts in combating climate change. This collaborative approach not only benefits the BRICS countries themselves but also contributes to a more sustainable and greener future for the entire global community.

CHAPTER 3

PROSPECTS FOR COOPERATION BETWEEN THE BRICS COUNTRIES

[3.1] LABOUR MARKET DEVELOPMENT, ENERGY SECTOR REFORMS, ENERGY EDUCATION AND HUMAN POTENTIAL

3.1.1 PURPOSE OF COOPERATION

The potential for cooperation between the BRICS countries in developing the labour market in the energy sector, energy education and human potential is vast and multifaceted. By harnessing their collective strengths and synergies, these countries could drive substantial progress in the sustainable energy transition, create significant employment opportunities, enhance skills development and boost energy education. The aim of this cooperation is to create a robust, shared framework that not only accelerates each country's individual transition to renewable energy, but also contributes to global sustainability goals.

Cooperation in Improving Human Potential and Human-Centred Approach

The human potential within the BRICS countries is vast. Harnessing this potential is critical to driving the energy transition forward and ensuring that it benefits all segments of society. Cooperation in this area can involve a series of initiatives aimed at training, improving skills and promoting inclusion. Collaboration in cultural and education exchanges among BRICS nations can yield numerous benefits, fostering a deeper understanding of each other's histories, traditions, and contemporary practices. This engagement promotes mutual respect and appreciation for cultural diversity, contributing to strengthened diplomatic ties and people-to-people connections. Implementing this point requires a multi-faceted approach that encompasses various strategies aimed at youth development.

The cooperation of the five countries in the field of human development and human-centeredness principles will contribute to the implementation of energy transition policies not only within the framework of sustainability and economic benefits, but also in order to maintain social inclusiveness.

By prioritizing cultural and education exchanges, BRICS nations can create a rich tapestry of cross-cultural connections, strengthening the bonds of friendship and collaboration within the bloc. These efforts not only enrich the lives of individuals but also contribute to the broader goal of fostering a more inclusive, interconnected, and harmonious future.

Training Initiatives

Capacity building can enhance the ability of individuals, communities and organizations to navigate and benefit from the energy transition. This can involve training programs, workshops and other initiatives designed to build skills, increase knowledge and build capacity. Joint capacity building initiatives can leverage the collective resources, knowledge and experience of the BRICS countries, increasing their effectiveness and reach.

BRICS countries can create joint academic programs that focus on cultural studies, language studies, and comparative literature. These programs can be offered at leading universities in each member country, allowing students to study abroad and immerse themselves in different cultural contexts. As well as joint academic programs that focus on cultural studies, language studies, and comparative literature. These programs can be offered at leading universities in each member country, allowing students to study abroad and immerse themselves in different cultural contexts.

Cross-Country Training and Skills Development Programmes

Training and skills development programs can equip workers with the skills needed in the energy sector. Transnational programs can offer learning opportunities from different contexts and experiences, promoting the sharing of knowledge and best practices. They can also help fill skills gaps and shortages by supporting labour market development in the energy sector. Collaboration in skills development and training can extend beyond traditional industries to include emerging sectors such as artificial intelligence, data analytics, and advanced manufacturing. BRICS countries can jointly design specialized training programs and certifications to address the demand for these cutting-edge skills, preparing their workforce for the jobs of the future.

Promoting Gender Equality and Inclusion in the Energy Sector

The energy sector has traditionally been male-dominated, and certain groups may face barriers to participation. Promoting gender equality and inclusion can ensure that the benefits of the energy transition are distributed equitably. This can involve initiatives aimed at supporting women and marginalized groups in the energy sector, such as mentoring programs, inclusive hiring practices and policies that promote diversity and inclusion.

Traditionally, the number of male employees in BRICS energy sector has significantly exceeded the number of females. That is generally in line with the global trends (women share 16% of labour resources in the energy sector and 39% in total labour force).

At the same time, each of the BRICS countries has programs to support and professionally develop women in the FEC, both in traditional industries and in the renewable energy. Sharing experiences and best practices among the BRICS countries would contribute to promoting women's role in the energy sector and possibly lead to the establishment of an informal professional association of women engaged in the FEC in BRICS countries.

Cooperation to enhance human potential can help BRICS countries ensure that their energy transition is not only sustainable and economically beneficial, but also socially inclusive. By empowering, upskilling and promoting inclusion, they can create a robust and diverse workforce that can bolster their energy transition efforts. Collaboration among BRICS nations for women empowerment holds immense potential to drive inclusive growth and sustainable development. By prioritizing this critical aspect, BRICS countries can unlock the untapped potential of women, promoting equal access to education, economic opportunities, and leadership roles. Through gender-inclusive policies, mentorship programs, and networking platforms, women can be equipped with the skills and support needed to excel in various sectors, including technology and entrepreneurship. By fostering a culture of respect and equality through awareness campaigns, BRICS nations can create a more equitable and empowered society, driving positive change on the global stage and setting a transformative example for generations to come.

3.1.2 MAIN DIRECTIONS FOR FUTURE COOPERATION

As the BRICS nations navigate their unique energy transitions, the direction of future cooperation will play a crucial role in shaping outcomes. By identifying and capitalizing on synergy opportunities, these nations can ensure that their collaborations are strategic, effective and beneficial to all.

To capitalize on synergy opportunities for future collaborations on energy skills and overall development, BRICS nations can take strategic steps. Working through the BRICS Energy Research Cooperation Platform, we need to focus on energy skills development and overall cooperation would facilitate regular dialogue and knowledge sharing. By recognising and utilising the diverse resources and capabilities within the bloc, BRICS countries can leverage their unique strengths for mutual benefit.

Defining common objectives and targets is vital to drive cohesive action among BRICS nations. This fosters a sense of collective purpose and enhances the effectiveness of collaborative initiatives. Promoting research and innovation is essential for advancing energy skills and overall cooperation. Encouraging joint research projects will foster knowledge creation and technological advancements in the energy sector, enhancing global competitiveness.

Facilitating knowledge exchange through faculty and student exchanges and workshops will disseminate best practices and expertise in the energy sector, laying the groundwork for more impactful collaborative efforts. Investment in infrastructure and digital connectivity will support seamless communication and data sharing, promoting closer ties within the bloc.

Policy coordination, human capital investment, and leveraging financial mechanisms like the New Development Bank are also vital. By fostering inclusive collaboration, BRICS countries can harness the collective power of their diversity and address the unique needs of their populations. In conclusion, by fostering a culture of cooperation, BRICS nations can create a powerful force for positive change, driving sustainable development, and contributing to a brighter future for their citizens and the global community.

Identification of Opportunities for Strategy

There are opportunities for synergy between the BRICS nations in various aspects of labour market development, energy education and human potential. From joint research initiatives and student exchange programs to shared labour market policies and inclusive employment practices, these synergies can drive substantial progress in these areas.

3.1.3 FACING CHALLENGES TO COOPERATION

While BRICS cooperation holds significant potential, it also faces various challenges that can impact its effectiveness and progress:

- **Divergent Interests**: Each BRICS country has its own unique economic, political, and strategic priorities, which can lead to divergent interests and approaches to cooperation. Finding common ground and consensus on various issues can be challenging.
- **Economic Disparities**: BRICS countries vary greatly in terms of economic development and size. Economic disparities can lead to imbalances in the distribution of benefits from cooperation, potentially leading to tensions and conflicts.
- **Infrastructure and Connectivity**: Inadequate infrastructure and connectivity between BRICS countries can impede the smooth flow of goods, services, and information, hindering deeper economic integration and collaboration.
- **Currency and Financial Cooperation**: Aligning financial systems and facilitating currency exchanges between BRICS nations can be challenging. Currency volatility and divergent financial regulations may hamper smooth economic interactions.
- **Trade Barriers and Protectionism**: Trade barriers, protectionist measures, and tariff disputes among BRICS countries can hinder economic integration and limit the potential benefits of cooperation.
- **Climate and Environmental Concerns**: Addressing climate change and environmental issues requires concerted efforts from BRICS countries. Balancing economic growth with sustainability goals can be a complex and delicate task.
- **Coordination and Implementation**: Ensuring effective coordination and implementation of joint projects and initiatives can be challenging, especially when dealing with diverse policies and bureaucratic processes across member countries.
- **Public Perception and Support**: Sustaining public support and understanding for BRICS cooperation is vital. Perceptions of the benefits and drawbacks of collaboration can influence the commitment of member countries and the broader public to the initiative.

Addressing these challenges requires continued dialogue, trust-building, and the willingness of BRICS countries to prioritize shared goals over individual interests. By effectively addressing these obstacles, BRICS cooperation can better harness its collective potential and play a more influential role in shaping global economic and geopolitical dynamics.

Strategies for Sustainable and Inclusive Cooperation

For cooperation to be effective, it needs to be sustainable and inclusive. This can involve long-term commitments, regular communication and coordination mechanisms, and efforts to ensure that all stakeholders – including workers, employers, educators and marginalized groups – are included in decision-making processes.

The direction of future cooperation among the BRICS nations will shape the development of their labour markets, the quality of their energy education and the extent to which they can harness their human potential. By focusing on synergy opportunities, proactively addressing challenges and prioritizing sustainable and inclusive cooperation, they can ensure that their collaborations lead to meaningful progress in these areas.

Analysis of the Cooperation Space

The space for cooperation between the BRICS countries in the development of the labour market in the energy sector, energy education and human potential is vast. However, it is also nuanced and complex, shaped by each country's unique characteristics, priorities and contexts. A thorough analysis of this cooperation space can provide valuable information to shape future collaborations.

3.1.4 CURRENT STATE OF COOPERATION

The space for cooperation between the BRICS countries in the development of the labour market in the energy sector, energy education and human potential is vast. However, it is also nuanced and complex, shaped by each country's unique characteristics, priorities and contexts. A thorough analysis of this cooperation space can provide valuable information to shape future collaborations. The bloc had established various mechanisms and platforms for collaboration across a wide range of areas, reflecting their shared commitment to strengthening partnerships and addressing common challenges. Some key aspects of the current cooperative space for BRICS include:

- **Summit Meetings**: BRICS leaders regularly convened at annual summits to discuss strategic issues, set priorities, and outline the bloc's agenda. These summits provided opportunities for high-level dialogue and decision-making on matters of mutual interest.
- **Ministerial Meetings**: BRICS countries held regular ministerial-level meetings across different sectors, such as finance, trade, education, health, and environment. These meetings fostered cooperation, facilitated policy coordination, and led to the signing of various bilateral and multilateral agreements.

- **Working Groups and Task Forces**: Working groups and task forces were established to address specific issues, conduct research, and explore collaborative initiatives. These groups focused on areas like science and technology, agriculture, energy, and anti-terrorism.
- **BRICS Business Council**: The BRICS Business Council brought together representatives from the private sectors of each member country to enhance economic ties, promote investment, and facilitate business opportunities within the bloc.
- **New Development Bank (NDB):** The NDB, founded by BRICS nations, provided financial support for infrastructure and sustainable development projects in member countries and other developing nations. The bank aimed to boost economic growth and foster closer economic ties within the bloc.
- **BRICS Think Tank Council**: The BRICS Think Tank Council served as an advisory body, bringing together think tanks and research institutions from member countries. The council provided policy recommendations and promoted intellectual exchange on various issues.
- **Academic and Educational Initiatives**: BRICS countries fostered academic collaborations through the Network of BRICS Universities and the BRICS Academic Forum. These initiatives facilitated research partnerships, student exchanges, and knowledge-sharing.
- **Cooperation in Global Forums**: BRICS countries coordinated their positions in various international forums such as the United Nations, G20, and World Trade Organization. They advocated for common interests and jointly addressed global challenges.

The cooperative space for BRICS remained dynamic and demonstrated the bloc's commitment to enhancing mutual understanding, promoting economic growth, and addressing global issues collectively. While the specific cooperative initiatives and mechanisms may have evolved since my last update, the essence of cooperation and shared commitment to collaboration among BRICS countries continue to play a vital role in shaping the global agenda.

3.1.5 POTENTIAL AREAS FOR FURTHER COLLABORATION

In pursuit of stronger cooperation and collective growth, the BRICS countries (Brazil, Russia, India, China, and South Africa) have the potential to explore various avenues for collaboration. Beyond their existing areas of focus, these emerging economies can further enhance their partnership in several critical domains. By leveraging their combined strengths, the BRICS nations can foster innovation, address pressing challenges, and contribute to sustainable development on both regional and global scales. There are several potential avenues for further collaboration among BRICS countries that can contribute to their collective growth and development. Some of these potential areas for cooperation include:

- **Digital Economy and E-commerce**: Embracing digital transformation and promoting e-commerce can open up new opportunities for economic growth and facilitate cross-border trade and investment among BRICS nations. By developing common standards and regulations, the bloc can create a conducive environment for digital trade and innovation, fostering a thriving digital economy.
- **Financial Cooperation and Currency Arrangements**: Exploring financial cooperation and currency arrangements, such as currency swaps or local currency settlement mechanisms, can enhance financial stability and reduce vulnerabilities to external economic shocks. This will strengthen economic ties among BRICS nations and promote greater financial resilience.
- **Water Resource Management**: Collaborating on water resource management, including conservation and sustainable use practices, can address water scarcity challenges and promote water security in the region. Sharing best practices and technology for water management can improve water access and ensure sustainable use of this vital resource.

By pursuing further collaboration in these areas, BRICS countries can strengthen their collective capabilities, enhance regional integration, and collectively contribute to global sustainable development and prosperity. Such collaborative efforts will not only benefit the member nations but also contribute to fostering a more balanced and inclusive global economic order.

3.1.6 PROSPECTS FOR FUTURE COOPERATION

The prospects for future cooperation between the BRICS countries in these areas are promising. As these nations continue to navigate their energy transitions, their need for cooperation is likely to increase. By collaborating effectively, they can address shared challenges, capitalize on emerging opportunities and drive their transitions towards a sustainable, inclusive and prosperous energy future. To this day there has been growing collaborations across the BRICS nations ranging across increasing frequency of Summits and meetings, growing trade and investment ties, coordinated positions in global forums, and enhanced people-to-people exchanges. As common goals become more aligned, and the distribution of resources and knowledge becomes more prevalent, it is expected that even more growth between the BRICS nations will be fostered.

CONCLUSION

The journey towards a sustainable and inclusive energy future presents both opportunities and challenges for the BRICS nations. The potential for collaboration among BRICS nations in the area of energy skills and labour market is vast and promising. By harnessing their collective strengths and expertise, these emerging economies can pave the way for substantial progress in the sustainable energy transition. Cooperation in energy education, skills development, and workforce training will not only contribute to the energy transition in BRICS countries but also contribute significantly to the SDGs.

The BRICS countries have the opportunity to jointly address common challenges, such as workforce transition, skills gaps, and job quality in the energy sector. By sharing best practices, aligning policies, and promoting regional labour market integration, they can create a skilled and adaptable workforce ready to thrive in industries during energy transition.

Cooperation in research, development, and faculty and student exchanges will lead to a higher quality of energy education and foster innovation in the energy sector. By investing in human potential and supporting the human-centred approach through but not limited to capacity-building programs and promoting gender equality, the bloc can ensure a diversified and competent workforce that benefits from the energy transition.

Collaborative efforts in the areas of energy skills recognition, data and knowledge sharing, and digital technology will further enhance the collective understanding and capacity of BRICS nations in managing their energy sectors efficiently. By embracing these opportunities for collaboration, the BRICS countries can position themselves as leaders in the global energy landscape and contribute significantly to a sustainable and prosperous future for the entire world.

FINAL THOUGHTS AND FORWARD-LOOKING STATEMENTS

The BRICS nations, with their diverse strengths and shared aspirations, have a unique opportunity to lead the way in the global energy transition. By harnessing the power of cooperation, they can ensure that this transition is not only sustainable and economically beneficial, but also socially inclusive and equitable. As they move forward, their collaborations will not only shape their own futures, but also contribute to the global transition towards a more sustainable, inclusive and prosperous energy future.

APPENDIX

INFORMAL STEERING COMMITTEE MEMBERS

Informal Steering Committee
BRICS Energy Research Cooperation Platform Report
"BRICS Energy Transition Skills Report"

Committee Members	Organisation
BRAZIL	
Giovani Vitoria Machado, Director for Energy Economics and Environmental Studies	Energy Research Company (EPE) Leading energy think-tank in Brazil
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Arijit Sengupta, Director	Bureau of Energy Efficiency

Committee Members	Organisation
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Disclaimer

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