BRICS 2024 RUSSIA



Energy of BRICS countries

energy practices for economic development

Information and Analytical Review of Energynet
Partnership Approaches and Solutions

ENERGY OF BRICS COUNTRIES
ENERGY PRACTICES
FOR ECONOMIC DEVELOPMENT

Information and Analytical Review of Energynet

Partnership Approaches and Solutions

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This review presents the approaches, practices and integrated technology products developed by the Energynet International Partnership to solve the urgent issues in BRICS electric power industry development.

The Energynet Partnership's activities rely on a balanced approach for electric power industry development offering SDG 7 achievement through economic and social development under the current challenges of climate change and growing inequality. For this, advanced technologies are needed to ensure autonomy, mobility and intelligence of power supply systems. The proposed technologies and practices allow solving the important energy problems of the BRICS countries in a new way.

The review is addressed to the representatives of government authorities, development institutions, state-owned companies, large businesses and entrepreneurial communities of the BRICS countries.

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CONCLUSIONS AND RECOMMENDATIONS

1. Most of the BRICS countries are among the fastest-developing large countries of the world. When planning the energy transition, it is critical for these very countries to find the balance between different sustainable development factors, namely: energy security, power supply efficiency, power grid operational reliability, and power supply environmental friendliness. These countries need to choose strategic goals and constraints to achieve them, with due account for their national interests. This will lay the foundation for a fair energy transition.

2. To achieve strategic goals and objectives of power industry development, it is necessary to rely on power grids' new useful properties, which are based on modern technologies. These properties are: autonomy, mobility and intelligence.

3. The new technologies are creating the opportunities for transformation of the power industry that will be much more responsive to the challenges the developing countries face. It is more adequate for the developing economies to change the "3D" approach (decarbonization, decentralization, digitalization) widespread in the developed economies for the other principles of power industry development, i.e. the "3C" approach: co-sufficiency, co-assembly and co-development.

4. 4. The BRICS countries are interested in sustainable and rapid economic growth, achieving high levels of welfare and human development. Depending on the development level and economy type, as well as their national strategies, the countries may address different priorities:

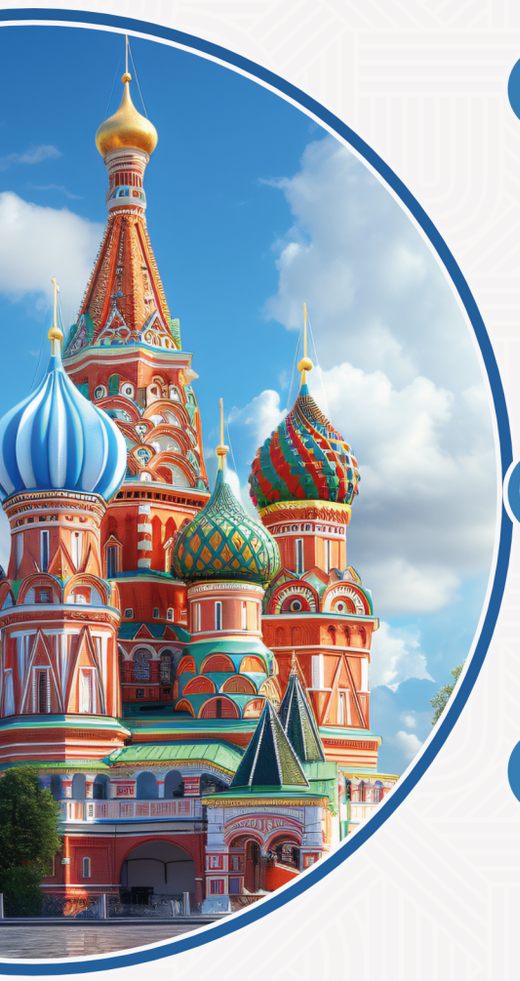
   - primary electrification of hard-to-reach areas
   - modernization of the industrial centralized power grid
   - building of a new energy structure, in the first instance in rapidly developing cities
   - development of electric mobility practices in industry, agriculture and transportation.

5. The Energynet Partnership offers the BRICS countries its technologies, solutions and competencies in the following areas:

- creation of microgrids in isolated and hard-to-reach areas
- modernization of worn-out power grid infrastructure by implementing the digital technologies
- development of municipal infrastructure of cities and settlements on the basis of Internet of energy systems
- distribution of electric mobility in transportation, industry and agriculture.

6. Mutually beneficial cooperation in the areas of science and education must become the basis for cooperation in power industry development in the BRICS. The Energynet Partnership proposes to conduct system research and development on the issues of fair energy transition, jointly create innovative hubs on the basis of national universities, create and develop an international network engineering school.

RUSSIAN FEDERATION



RUSSIA'S ENERGY

Today		in 2035
Installed Power Capacity:		
248 GW	+6%	**264 GW**
Annual Electricity Consumption:		
1122 billion kWh	+20%	**1345 billion kWh**
Public Access to Electricity:		
100%	+0%	**100%**

ELECTRICITY COSTS, 2023, US$/MWH

Household **53**

Business **78**

OPTIMAL PRICING STRATEGY

Strategy of Containing Price Growth within the Target Inflation Rate

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: **1678 million tons of CO_2eq per year**

CLIMATE COMMITMENTS

- Carbon Neutrality by 2060
- **70% from 1990 levels** Reduction of CO_2 Emissions by 2030
-

SHARE OF RENEWABLES – 20%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
HIGH	HIGH	MEDIUM	MEDIUM

CURRENT ENERGY AGENDA OF THE BRICS COUNTRIES

The current global energy agenda is to achieve the UN's seventh Sustainable Development Goal: universal access to inexpensive, reliable, sustainable and modern energy sources for everyone. As global climate change has accelerated in the recent years, this agenda is often considered only from a sustainability perspective, or more specifically, from the perspective of the need to reduce man-induced carbon dioxide emissions. As far as energy transition issues for the developing economies are concerned it is necessary to take into account a more complex set of sustainable development factors: energy security (energy availability), power supply efficiency, power grid operational reliability, power supply environmental friendliness.

The energy transition implies a change in the energy structure, changeover to new technologies and practices along the entire chain of producing primary energy and transforming it into useful work. The history of energy structures changing has demonstrated many times that such transitions create qualitatively new opportunities for development of economy and society.

The BRICS countries, i.e. the Federative Republic of Brazil, the Russian Federation, the Republic of India, the People's Republic of China, the Republic of South Africa, the United Arab Emirates, the Kingdom of Saudi Arabia, the Islamic Republic of Iran, the Arab Republic of Egypt and the Federal Democratic Republic of Ethiopia, can be mainly characterized as the fastest-developing large countries of the world. When planning the energy transition, it is critical for these very countries to find the balance between sustainable development factors, to choose strategic goals and constraints to achieve them with due account for their national interests.

FEDERATIVE REPUBLIC OF BRAZIL



BRAZIL'S ENERGY

Today		in 2031
Installed Power Capacity:		
208 GW	+32%	**275 GW**
Annual Electricity Consumption:		
551 billion kWh	+44%	**792 billion kWh**
Public Access to Electricity:		
99,5%	+0,5%	**100%**

ELECTRICITY COSTS, 2023, US$/MWH

- Household **136**
- Business **120**

OPTIMAL PRICING STRATEGY

Strategy of Reducing Prices to a Competitive Level

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: **413 million tons of CO_2eq per year**

КЛИМАТИЧЕСКИЕ ОБЯЗАТЕЛЬСТВА

- Carbon Neutrality by 2050
- **50% from 2005 levels** Reduction of CO_2 Emissions by 2030

SHARE OF RENEWABLES – 87,92%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
MEDIUM	HIGH	MEDIUM	HIGH

REPUBLIC OF INDIA

INDIA'S ENERGY

Today **in 2030**

Installed Power Capacity:

410 GW +120% **900 GW**

Annual Electricity Consumption:

1207 billion kWh +77% **2133 billion kWh**

Public Access to Electricity:

99,6% +0,4% **100%**



ELECTRICITY COSTS, 2023, US$/MWH

- Household **65**
- Business **107**

OPTIMAL PRICING STRATEGY

Strategy of Reducing Prices to a Competitive Level

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: **2279 million tons of CO_2eq per year**

CLIMATE COMMITMENTS

- Carbon Neutrality by 2070
- Reduction of CO_2 Emissions to **45% from 2005 levels** by 2030
- 22% Reduction of Specific CO_2 Emissions from Electricity Generation by 2032

SHARE OF RENEWABLES – 21,32%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
MEDIUM	HIGH	HIGH	HIGH

Strategic Challenges

At present, the world's countries are self-identifying in a strategic sense based on climate, economy, resources, technologies and the associated challenges. The national programs of the BRICS countries' transition to the new energy structure must meet the following challenges:

1. **Climate**. The global energy transition policy has been so far mainly focused on reducing greenhouse gases emission and suppressing (mitigating) climate change. At present, climate is changing more rapidly, and negative effect of these changes on economic activity and safety of human life is growing more intense. More and more resources and efforts need to be spent for adapting the energy infrastructure to the new climate conditions. Reliable operation of the power grid under these new conditions becomes a high-priority goal.

2. **Economy.** The BRICS countries have taken the path of technological progress and economic growth later than the advanced economies. The BRICS countries' economies have not yet reached the same high level of productivity and labour efficiency, consequently the standard of living is not so high there. Achieving a high labour efficiency, developing new economic practices, overcoming poverty and inequality in living standards are high-priority goals for the BRICS countries. This requires accessible and cheap energy that effectively supports both old and new economic activities.

3. **Resources.** Climatic changes, natural population growth and increasing migration processes, resource depletion in the developed territories result in the need to implement new directions of spatial development. Many BRICS countries have areas that are still poorly developed as it is difficult for the traditional infrastructures to reach such territories. A need and an opportunity for economic development of these territories to bring more resources into circulation and consumption arise at the same time. For this, it is important to develop the local energy sector based on the resource autonomy principle.

4. **Technologies.** The world is currently experiencing a new industrial revolution due to invention and large-scale distribution of cyber-physical systems. Deep robotization of industry, transport and agriculture lies ahead and is already underway in many ways. Consequently, there is a huge demand for mobile power industry based on various energy storage technologies and alternative fuels.

An adequate response to these challenges for the developing world is to focus the energy transition, in the first place, on the goals and objectives of economy and society development. At the same time, the problems of climate change, spatial development and independent (sovereign) technological development belong to the important, but boundary conditions for implementing the main target function: efficient and therefore affordable power supply. Both the obligations assumed and the actual capacities of each country determine the strategy development constraints.

PEOPLE'S REPUBLIC OF CHINA

CHINA'S ENERGY

Today **in 2030**

Installed Power Capacity:

2563 GW ..... +56% .....▸ **4000 GW**

Annual Electricity Consumption:

7581 billion kWh .... +56% ..▸ **11800 billion kWh**

Public Access to Electricity:

100% ..... +0% .....▸ **100%**



ELECTRICITY COSTS, 2023, US$/MWH

Household **68**

Business **78**

OPTIMAL PRICING STRATEGY

Strategy of Containing Price Growth within the Target Inflation Rate

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: **10649 million tons of CO_2eq per year**

CLIMATE COMMITMENTS

- **30%** Reduction of Methane Emissions by 2030
- Carbon Neutrality by 2060

SHARE OF RENEWABLES – 30,59%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
MEDIUM	HIGH	HIGH	HIGH

REPUBLIC OF SOUTH AFRICA



RCA'S ENERGY

Today **in 2030**

Installed Power Capacity:

54 GW ..... +53% ..... ▸ **83 GW**

Annual Electricity Consumption:

193 billion kWh ..... +42% ..... ▸ **275 billion kWh**

Public Access to Electricity:

89,3% ..... +10,7% ..... ▸ **~100%**

ELECTRICITY COSTS, 2023, US$/MWH

Household **150**

Business **72**

OPTIMAL PRICING STRATEGY

Strategy of Reducing Prices to a Competitive Level

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: **392 million tons of CO_2eq per year**

CLIMATE COMMITMENTS

- Carbon Neutrality by 2050 г.
- Reduction of GHG Emissions to **350–420 million tons of CO_2eq** by 2030

SHARE OF RENEWABLES – 8,46%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
HIGH	HIGH	MEDIUM	HIGH

New Technological Opportunities

The power industry's new technological package, which is being formed and developed at a rapid pace recently, allows responding to these challenges. New discoveries and technologies in the sphere of electrochemistry, composite materials, power electronics, digital intelligent control create opportunities for qualitative changes in power grids, rather than only replace some elements with others in the power grids without creating new consumer properties. This is why technologies are essential for transition to the new energy structure. It is not just a growing share of new energy sources in power balances.

To achieve strategic goals and objectives of power industry development, it is necessary to rely on power grids' new useful properties, which are based on modern technologies. These properties are:

- **Autonomy** – the capability to produce energy near the places of its consumption without the need for constant supply of energy resources from outside

- **Mobility** – the capability to provide available energy in a flexible way within different dynamic processes (including for vehicles, mobile robots, temporary settlements)

- **Intelligence** – the capability to manage energy supply processes with qualitatively increasing complexity in the optimum way without permanent human participation.

These new properties of power grids created due to transition to the next technology package will increase the productivity of the national economies of the BRICS countries, because they ensure the growth of energy capacity in hard-to-reach areas, intensify production processes in industry and agriculture as a result of their robotization, speed up the transportation of people and cargo due to a higher specific capacity of energy sources, high efficiency in energy infrastructures management in combination with other infrastructures and various energy consumption processes. The autonomy and intelligence properties ensure high reliability of power supply systems including at a greater impact of natural hazards associated with climatic changes. On the other hand, scaling up such power grids using low-carbon solutions will maintain man-induced greenhouse gases emission at low levels even at energy consumption increase.

ISLAMIC REPUBLIC OF IRAN



IRAN'S ENERGY

Today **in 2030**

Installed Power Capacity:

90 GW ..... +22% ..... ▸ **100 GW**

Annual Electricity Consumption:

301 billion kWh ..... +23% ..... ▸ **369 billion kWh**

Public Access to Electricity:

100% ..... +0% ..... ▸ **100%**

ELECTRICITY COSTS, 2023, US$/MWH

Household **2,7**

Business **NA**

OPTIMAL PRICING STRATEGY

Managed Price Growth Strategy

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: **643 million tons of CO_2eq per year**

CLIMATE COMMITMENTS

- 12% from 2015 levels Reduction of GHG Emissions by 2030
- No Publicly Stated Climate Neutrality Goals

SHARE OF RENEWABLES – 4,8%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
HIGH	HIGH	LOW	MEDIUM

ARAB REPUBLIC OF EGYPT

EGYPT'S ENERGY

Today **in 2030**

Installed Power Capacity:

59 GW ..... +98% ..... ▸ **117 GW**

Annual Electricity Consumption:

159 billion kWh ..... +143% ..... ▸ **385 billion kWh**

Public Access to Electricity:

100% ..... +0% ..... ▸ **100%**



ELECTRICITY COSTS, 2023, US$/MWH

Household **25**

Business **32**

OPTIMAL PRICING STRATEGY

Managed Price Growth Strategy

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: **207 million tons of CO_2eq per year**

CLIMATE COMMITMENTS

- **25%** Reduction of CO_2 Emissions from the Energy Industry by 2030
- **37%** Reduction of GHG Emissions by 2030

SHARE OF RENEWABLES – 11,47%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
HIGH	HIGH	LOW	MEDIUM

Principles of Power Industry Development in the XXI Century

The current energy agenda of the BRICS countries goes beyond the climate policy and must be mainly focused on the goals and objectives of economy and society development. Therefore, these countries cannot adopt the energy transition principles widely spread in the developed world, which has been primarily concerned with the climate problems. These principles are commonly expressed in words "decarbonization, decentralization, digitalization" ("3D"). The new technologies are creating the opportunities for transformation of the power industry that will be much more responsive to the challenges the developing countries face. It is suggested to follow the other principles of power industry development, i.e. the "3C" approach:

1. **Co-sufficiency**: producing dissipated energy (primarily renewable energy) from the environment without irreversible disturbance of its useful properties in close proximity to the consumer, energy storage and transformation into usable forms in combination with the conventional power industry and the use of highly concentrated forms of energy that reduce the need for energy supply (e.g., small-scale nuclear power plants). The main technological prerequisite for implementing this principle is energy flexibility management solutions based on load management devices, energy storage and hydrogen technologies.

2. **Co-assembly**: integration and distributed robotic control of energy sources and flexibility as well as active consumers (including mobile consumers) and infrastructure for coordinated optimization of reliable power supply. The main technological prerequisite for implementing this principle is the solutions for seamless network integration of active subscribers and reliable management of energy transactions between them.

3. **Co-development**: building and customizing of economic relations essential for the energy sector expansion taking into account the urgent issues of the society and natural constraints. The main technological prerequisite for implementing this principle is platform solutions needed to provide intelligent energy services for energy subscribers of various types.

The "3C" principles will make it possible to create the power industry of the XXI century, which opens truly new opportunities for development of economy and society, and provides a comprehensive response to today's challenges.

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

ETHIOPIA'S ENERGY

Today		in 2030
Installed Power Capacity:		
5,6 GW	+255%	**19,9 GW**
Annual Electricity Consumption:		
11,2 billion kWh	+255%	**39,8 billion kWh**
Public Access to Electricity:		
54,2%	+77%	**96%**



ELECTRICITY COSTS, 2023, US$/MWH

Household **5,1**

Business **19,5**

OPTIMAL PRICING STRATEGY

Managed Price Growth Strategy

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: **13 million tons of CO_2eq per year**

CLIMATE COMMITMENTS

- Carbon Neutrality by 2050
- Reduction of CO_2 Emissions to **1.1 tons per capita** by 2030

SHARE OF RENEWABLES – 30,59%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
HIGH	MEDIUM	LOW	LOW

UNITED ARAB EMIRATES



UAE'S ENERGY

Today **in 2030**

Installed Power Capacity:

38 GW ..... +52% ..... ▸ **52 GW**

Annual Electricity Consumption:

135 billion kWh ..... +73% ..... ▸ **369 billion kWh**

Public Access to Electricity:

100% ..... +0% ..... ▸ **100%**

ELECTRICITY COSTS, 2023, US$/MWH

Household **80**

Business **110**

OPTIMAL PRICING STRATEGY

Strategy of Reducing Prices to a Competitive Level

GREENHOUSE GAS EMISSIONS

Emissions from the Energy Industry: 1**81 million tons of CO_2eq per year**

CLIMATE COMMITMENTS

- **100%** Reduction of Specific CO_2 Emissions from Electricity Generation by 2050
- Carbon Neutrality by 2050

SHARE OF RENEWABLES – 3,99%

DEMAND FOR ENERGYNET PARTNERSHIP SOLUTIONS

Microgrids for Site Electrification	Digital Network Infrastructure Modernization	Internet of Energy for Cities and Settlements	Electric Mobility for Transport, Industry and Agriculture
MEDIUM	HIGH	HIGH	MEDIUM

KEY GOALS OF BRICS POWER INDUSTRY DEVELOPMENT

The BRICS countries are countries with developing economies. They are all interested in sustainable and rapid economic growth, achieving high levels of welfare and human development of their population. One of the significant factors in these processes is sustainable interaction of the economy and society with the environment. But, depending on the development level and economy type, as well as their national strategies, the countries may address different development priorities: primary electrification of hard-to-reach areas, modernization of the industrial power grid or building of a new energy structure, development of electric mobility practices in industry, agriculture and transportation.

Electrification of isolated and hard-to-reach areas based on old technologies leads to a high cost of power supply, which limits the development potential of these areas. The technologies of building microgrids (microenergy systems) based on renewable energy sources, fuel generation, energy storage and hydrogen technologies, as well as management systems allow implementing more economically attractive power supply solutions. The key objective is to ensure low cost of energy supplied to consumers.

Modernization of power grids of the existing structure implies natural replacement of worn-out power generating and grid facilities, development of new energy sources, growth of consumers' requirements to power supply reliability and quality. In this context, a special role is played by new solutions for distribution power networks required for building a new generation infrastructure - **digital power networks**. In this regard, the key objective is to modernize the power network in a way that best meets the new requirements of power grid participants while keeping the cost of infrastructure ownership at the stable level.

The development of municipal infrastructure in cities and settlements as part of the transition to the new structure implies the distribution of effective practices for utilizing the new opportunities of autonomy, mobility and intelligence of power grids. The key role in meeting this objective will be played by complex interlinked municipal systems managing the flexible transformation of a wide range of energy sources into various forms (electricity, heat, hydrogen), using distributed sources of energy flexibility (from electric vehicles to prosumers), and creating various customized services for consumers. This class of solutions is commonly referred to as **Internet of Energy**. The key objective in this area is to ensure a high degree of flexibility and manageability of processes, as well as to ensure major economic benefits from the coordinated management of infrastructures and subscribers throughout their life cycle.

The large-scale development of electric mobility and secondary electrification of industry, agriculture, and vehicles of various types is becoming a symbol of our time. These are not only the conventional electric vehicles and electric buses, but unmanned aerial vehicles, river and sea vessels, and robots as well. The technologies for creating power plants with high operational range and power density, as well as the solutions for charging and hydrogen refueling infrastructure for mobile systems, will play a key role in development of this area. The key objective is to make energy available for mobile systems at a reasonable cost.

Markets of Integrated Solutions for BRICS Electric Power Industry Development

The predicted size of the markets of integrated solutions for BRICS electric power industry development that will be reached by 2030 is summarized in Table 1. The market of electrification solutions for hard-to-reach areas is evaluating the cost of building micro and minigrids operating isolated from the power system. The market of digital modernization solutions for the grid energy sector includes the costs of building new digital networks and modernizing the existing distribution networks to a digital state, including the costs of network equipment and construction and installation works, upgrading software and control systems. The Internet of Energy solutions market includes the costs for control system, detectors, sensors and actuators, power management tools, and urban energy flexibility management equipment. The electric mobility market includes the costs for electric vehicle charging infrastructure, software, and control systems.

Table 1. Predicted size of the markets of integrated solutions for BRICS electric power industry development in 2030, $ mln per year

	Electrification of hard-to-reach areas	Digital modernization of grid energy sector	Internet of energy for development of cities and settlements	Electric mobility in transportation, industry and agriculture
Brazil	162	12,120	196	1245
Russia	176	4130	170	910
India	322	33,890	322	2514
China	212	31,300	2045	6497
South Africa	1709	5221	162	1150
Iran	114	3870	11	754
Egypt	136	2756	16	512
Ethiopia	1614	873	4	89
United Arab Emirates	96	903	82	321
BRICS, total	**4,541**	**95,063**	**4,786**	**13,992**

The estimates in Table 1 are based on the data from World Bank, ESMAP, SE4All, BNEF, Kept, Statista as an average forecast, partly obtained by extrapolation of historical data on the rate of development of energy infrastructure and relevant markets, partly based on model estimates of investment needs for development of power grids in the countries, ensuring access of the population to electric energy and energy services.

ENERGYNET INTEGRATED SOLUTIONS FOR URGENT ISSUES

The Energynet Partnership is an association of business companies and research universities that develop new technologies and practices in the electric power industry. The Partnership is united by the ideas of forming new integrated market solutions for a fair, balanced energy transition, accumulating and transferring industry knowledge while training new generations of engineers, and cooperating with interested communities of specialists all over the world to realize joint research and practical tasks.

The Energynet Partnership was established in 2016 and includes currently:

- Over 5000 industry experts, engineers and specialists in the fields of reliable and flexible networks, intelligent distributed power systems, digital user services, cybersecurity, energy storage systems, and hydrogen technologies
- Over 100 technology companies of various profiles
- Over 40 research universities training engineers and technicians in the Russian Federation and worldwide
- Advanced Competence Centers in the fields of “New and Mobile Energy Sources”, “Hydrogen Infrastructure and Technologies”, “Technologies of Electric Power Transmission and Distributed Intelligent Power Systems”, “Diagnostics of Distribution Power Grid Facilities”
- Future Power Grids Center “EnergyNet” that conducts research, expertise, standardization activities, and project support for new technologies and business practices.

The Energynet Partnership has focused on state-of-the-art technologies for electric power distribution and energy flexibility management, integration of distributed energy sources, hydrogen production, storage and energy applications, electric energy storage, electric mobility, power grid intelligent management, and utilization of distributed registries. These technologies enable to create effective integrated solutions and practices for power supply systems development in cooperation with national power equipment suppliers.

Microgrids for Electrification of Isolated and Hard-to-Reach Areas

Many BRICS countries have isolated and hard-to-reach areas where it is not possible or economically affordable to develop centralized energy infrastructure. In order to arrange for power supply to such areas, diesel power plants operating on imported fuel are usually used. However, more and more power supply projects have been implemented recently based on hybrid power plants using renewable energy sources and local fuels available in the certain area. Such hybrid energy sources in combination with energy storage systems, controllable loads and intelligent control systems make up integrated technical solutions referred to as microgrids. The analysis results show that the market of power supply solutions for isolated and hard-to-reach areas in the BRICS countries will be around $4.5 billion in 2035.

In many cases, power supply to isolated and hard-to-reach areas based on the traditional solutions is very expensive ($0.5 to $2 per kW h or even more). Besides, diesel power plants operating on hydrocarbon fuels have high specific carbon dioxide emissions (about 750 g of CO2-eq./kW h). The **key problem** for this class of power supply systems is to achieve a significant drop in the power supply cost and reduce carbon dioxide emissions and provide the required reliability level at the same time.

To solve this problem, **microgrids should be created** using hybrid power plants, combining generators operating on renewable energy sources and local fuels, and diesel power plants operating on imported fuel. The right balance of different power generation types guarantees the best cost of power supply while maintaining the proper level of carbon dioxide emissions and power supply reliability. The second important means of solving the problem is intelligent energy flexibility management for microgrid facilities (mobile power plants, energy storage units, controllable loads). In many cases, the extra costs associated with creation of the necessary energy flexibility sources and their controls within a microgrid can yield an additional 10-20% reduction in the power supply cost.

The key **process solutions** for arranging microgrids in isolated and hard-to-reach areas are:

- Digital multi-parameter simulation tools for determining the composition of power equipment being optimum in terms of power supply cost, taking into account the target level of carbon dioxide emissions and power supply reliability
- Automated hybrid power complexes providing joint control of generators operating on different energy sources
- Energy storage systems of various types (including hydrogen cycle energy storage) providing microgrid with additional energy flexibility sources
- Tools for maintaining operational stability during operation without main diesel power plants
- Intelligent control systems providing integrated optimum management of energy sources and energy flexibility
- Ontology platforms equipped with semantic technologies and logical inference tools, compliant with international standards CIM and OWL, and used for creating and maintaining the sectoral information models of power facilities.

Case: Digital simulation for optimizing the isolated microgrids power supply

Location: Far Eastern regions of Russia, facilities in the Middle East.

Problem: determination of economically optimum set of power supply facilities for the isolated area with a great reduction of CO_2 emissions.

Solution: creation of hybrid power plants and mini-grids comprising diesel power plants, renewable energy sources (RES) and energy flexibility sources (controllable load and/ or energy storage systems).

Effect (design): reducing the cost of power supply to an isolated area by 40%, reducing CO2 emissions by 80%.



Case: Creation of a universal CIM model for isolated microgrids

Location: Far Eastern regions of Russia.

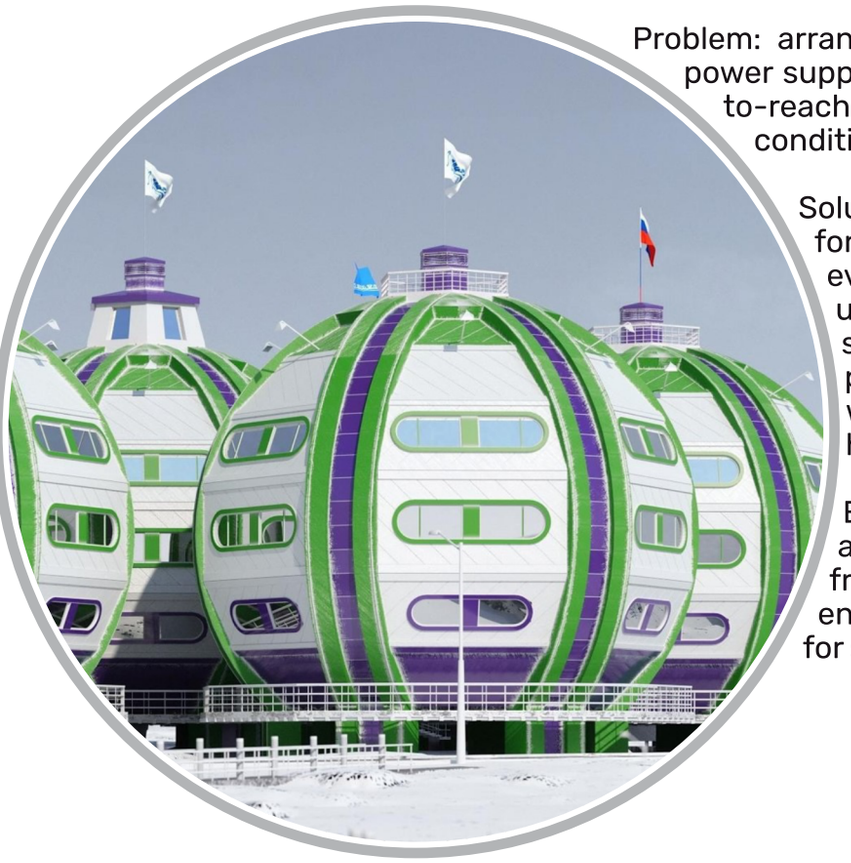
Problem: high labour intensity and cost of integration of information and automation systems, high labour intensity and cost of data collection necessary for reliable operation and regulated operation of isolated microgrids.

Solution: creation of machine-readable ontological models of microgrids based on CIM, model-based integration of dissimilar information systems.

Effect (expected): reduction in the cost of creating and operating the information systems for isolated microgrids by more than 30% due to reuse and interoperability of system elements.

Case: Carbon-free microgrid of International Arctic station “Snezhinka”

Location: The Arctic region of Russia.



Problem: arranging for autonomous carbon-free power supply to facilities in isolated and hard-to-reach areas with severe climatic conditions.

Solution: ccreation of a testing ground for approbation and economic evaluation of hydrogen technologies used in isolated and hard-to-reach settlements, creation of a hybrid power plant based on wind energy with energy storage in the form of hydrogen and heat/cold.

Effect (expected): high resource autonomy on the basis of carbon-free energy sources, provided by energy stored in the form of hydrogen for seven days of no-wind conditions.

The Energynet Partnership **offers** the interested BRICS countries:

1. Feasibility simulation tools and services for calculating optimum configurations and economic effects of microgrids creating and upgrading
2. Microgrids designing with energy flexibility management capabilities
3. Creating micro and minigrids of various complexity
4. OSA ontology platform designed for solving system engineering tasks, including SIM-simulation of power facilities
5. Creation of experimental testing grounds for studying and demonstrating new technical solutions for microgrids (including those based on hydrogen technologies).

Digital Solutions for Modernization of Worn-out Power Grid Infrastructure

In the BRICS countries, centralized industrialized power grids began to appear in the last century, when other requirements for availability, reliability, and quality of power supply were imposed. Besides, over the years, the distribution grid within the industrial power grids has in practice received less attention than backbone power plants and supergrid facilities. In this regard, electrical power distribution complexes are often characterized today by a high degree of wear and tear and obsolescence of equipment. On the other hand, distribution grids are the last infrastructural link in the chain of electric power supply to consumers, and consumer satisfaction with operation of the entire power grid depends on their performance. At the same time, large-scale development of distributed power systems, the emergence of new types of energy exchange participants, as well as the objectives of a deeper electrification of areas make the requirements for distribution grids as a key infrastructure component of the energy transition much more strict. Nowadays, new digital technologies and achievements in electrical engineering have made it possible to significantly improve the distribution grid consumer properties. The new generation of such grids can be called digital grids. The analysis results show that the BRICS digital power distribution grid market is expected to reach over 95.1 billion USD in 2035.

The **key problem** for modernization of the distribution grid based on modern digital and electrical technologies is a notable increase in capital and operating costs and, consequently, an increase in electricity transportation tariffs. However, the best modernization practices demonstrate that it is possible to significantly improve availability, reliability and quality of power supply without increasing the tariff for grid services.

To solve the problem, **it is necessary to carry out a comprehensive change** in the technical, functional-organizational and economic-legal models of the grid organization by means of the following solutions:

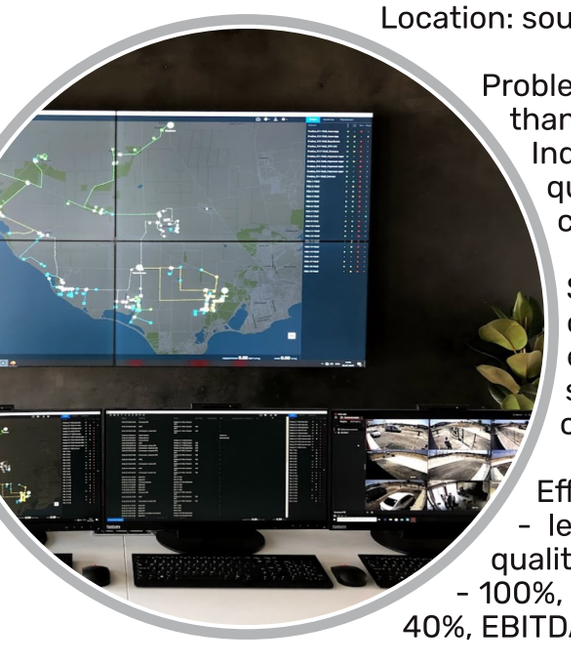
- Power grid development planning based on a structured geoinformation mathematical model formed on the open ontology principles (grid model building standards)
- Transition from radial to ring and complex closed power grid topologies by introducing the alternative routes of power supply to consumers and automatic emergency response operational switching
- Use of highly automated switching devices, transition from the use of traditional two-transformer substations to transformation points
- Using the power grid geoinformation model in all business processes of the grid company (outage management, development management, electricity transportation management, fund and asset management)
- Implementing the automated algorithms for accident detection, containment and elimination compatible with distributed power systems, online decision support systems
- Transition to a predictive asset management system, when all assets of the distribution grid are formally classified, the types of their defects, the consequences of these defects, the ways and costs of eliminating these defects and consequences in connection with the power grid geoinformation model are described.
- Re-engineering of all business processes and organizational models of a grid company – a complete digital transformation of activities

- Development and implementation of professional training and retraining of engineers and operating personnel in the field of digital networks.

The following basic **technical solutions** are used to create a digital distribution power grid:

- Structured geoinformation mathematical model of the grid - a digital twin
- A digital design system based on a digital twin of the power grid
- Compact and simple functional analogs of digital substations – transformation points
- Intelligent automatic switching devices that do not require individual settings
- A supervisory control system based on a digital twin of the power grid
- An intelligent relay protection system based on the multi-agent approach.

Case: Digital Area of Power Grid



Location: south regions of Russia.

Problem: mainly overhead power grids, worn-out by more than 70%, SAIDI (System Average Interruption Duration Index) - 16 hours/year; availability in terms of power quality - 68%, availability for connection of new consumers - 34%.

Solution: creation of an auto-cluster power grid with an optimum ring topology, modernization of worn-out equipment, introduction of the decision support system based on a digital twin, and organizational changes in the grid company.

Effect (expected): critically worn-out assets - none, SAIDI - less than 2 hours/year, availability in terms of power quality - 100%, availability for connection of new consumers - 100%, power losses - less than 5%, OPEX reduction - at least 40%, EBITDA of the grid company operator - more than 20%.

Case: Distributed Automation as Smart Grids Subsystem



Location: Grid companies in Brazil

Problem: mainly overhead power grids, major damage, liability of grid companies - concessioners to consumers.

Solution: Installation of more than 4000 intelligent sectionalizing devices (reclosers) in overhead distribution grids, which ensure automatic isolation of the damaged grid section in case of emergencies.

Effect: SAIDI improvement by 20%.

Case: Power Grid Intelligent Protection and Automation System

Location: Regions of Russia.

Problem: the implemented digital technologies compliant with IEC 61850 almost in all cases lead to a 50-70% increase in CAPEX and OPEX for creation of digital protection and automation systems at 110-500 kV substations. At the same time, reliability indicators drop: the availability factor for a number of functions decreases from 0.96 to 0.8 and below.



Solution: creation of an intelligent protection and automation system with the functions of self-adjustment, self-organization and self-recovery. The solution is based on software redundancy applied instead of hardware redundancy. It means that if a microprocessor-based protection device fails, redundancy will be provided by migration (within 100 ms maximum) of the failed device functions to the other devices in operation.

Effect: CAPEX and OPEX reduction by 30-40% as compared to traditional (non-digital solutions), up to 2 times reduction in the cost of ownership as compared to typical solutions for digital substations, increase in availability factor up to 0.98-0.99.

The Energynet Partnership **offers** the interested BRICS countries:

1. Integrated solutions for modernization of distribution grids which improves reliability, quality, and affordability of power supply without increasing tariffs for consumers

2. Digital tools for automated generative design of distribution power grids, including distributed power systems, with the possibility of optimum equipment selection and automatic generation of schemes and parameters for technological protections

3. Process solutions for intelligent protection and automation systems of power grids

4. Intelligent switching and power converter equipment for construction and modernization of distribution grids, as well as for integration of distributed power systems into distribution grids

5. Test systems, equipment and services for testing of electrical equipment, protection and automation schemes and parameters of distribution power grids.

Internet of Energy for Development of Municipal Infrastructure in Cities and Settlements

To shape a new technical and economic structure associated with post-industrial transformation of cities, widespread use of cyber-physical systems in industry, agriculture and transportation, transition to intelligent digital systems for managing urban infrastructures and services, the BRICS countries are interested in creating new generation power grids. Such systems are commonly referred to as the Internet of Energy because they provide seamless integration of distributed active consumers, energy sources and energy flexibility, as well as intelligent management of energy exchange between them. The Internet of Energy creates opportunities for developing new energy practices, improving the efficiency of distributed energy sources utilization, engaging energy flexibility sources, providing network subscribers with a variety of digital and energy services, and, in the future, integrating various urban systems into a single multi-infrastructure. The analysis results show that the market of BRICS Internet of Energy systems will be around $4.8 billion in 2035.

The key problem for integration and coordinated management of distributed active subscribers of the power grid such as prosumers, distributed energy sources, energy storage systems, and electric vehicles is the increase in associated costs with management becoming more complex at the same time. Three types of such costs can be distinguished:

- **Transaction costs** associated with organization of economic interaction (conclusion of contracts, accounting, financial settlements, settlement of disputes), growing as the number of active participants in the power grid grows
- **Information integration** costs associated with the need to include a great number of power grid participants in control loops and information channels for data and command exchange
- **Costs of physical (electrotechnical) integration** of new equipment into the power grid, associated with the complexity of ensuring reliable and safe operation of the power grid, as well as its operational stability with a great number of active subscribers connected to the grid.

Without solving this key problem, the expected increase in the power grid functionality will be accompanied by a significant increase in its maintenance costs. The main approach to solve the said problem is to transfer from the separate management of economic relations, information exchange and power devices when establishing power supply modes to the management of energy transactions that combine all these three types of interaction. Technically, this is ensured by coordinated operation of the following systems:

- **Transactive energy**: A system for implementing the commercial component of energy transactions, involving the fully automatic formation and secure storage of smart contracts that record the parameters of energy transactions, verification of their execution, financial payment under fulfilled obligations, recording of discrepancies and disputes, use of data for their resolution and performance of clearing functions.
- **Internet of Things**: A system for implementing the information component of energy transactions, involving machine-to-machine (M2M) interaction and exchange with all the information and control signals necessary for energy transactions between subscribers' equipment and their software systems, access of software systems to local automatic devices of equipment and/or local

control systems, as well as generation, storage and provision of digital twins and digital shadows of subscribers' systems and their equipment, operation of auxiliary software for machine-to-machine interaction.
- **Neural Grid**: A system for implementing the physical (electrotechnical) component of energy transactions, which, if necessary, provides for decentralised regulation of power flows in the energy system to form the mode of power transmission necessary for the implementation of energy transactions under conditions of simultaneous implementation of multiple energy transactions.

The following basic **technical solutions** are used to create an Internet of Energy system:

- Transactional digital platform and user applications
- IoT-platform, smart meters, detectors, sensors and actuators
- Power flow regulators (power routers), power balance reference regulators (power hubs), power output (consumption) regulators (power ports), adaptive relay protection and automation
- Intelligent control systems, including those based on the principles of decentralized, multi-agent control.

New energy practices involving the active interaction of multiple energy exchange participants, such as smart energy consumption, meter-to-cache services, distributed energy aggregators, smart communities, and localized energy markets, will be implemented on the basis of Internet of Energy technologies as they are scaled up.

Case: Smart Energy Consumption



Location: facilities with high energy consumption (shopping centers, ice arenas, fast-food restaurants, industrial enterprises) – more than 150 facilities in Russia.

Problem: active consumers while using new power equipment (RES, heat pumps, energy storage systems, controllable load, charging stations) face many difficulties that can only be solved by involvement of dozens of highly qualified specialists, which not every business can afford.

Solution: an artificial intelligence-based hardware and software consumption management system turns the consumer's power utilities into a “smart” microgrid, linking all devices at the instrument level with the help of sensors and controllers, and building a reference consumption for a specific facility at the level of “digital twins”.
The main task of the system is to bring power consumption of the facility close to the reference level and achieve the most economical mode while keeping the preset consumer parameters (e.g. indoor temperature and CO2 level, etc.).

Effects: reducing the connected capacity need by 10–20%, reducing electricity, heat and gas costs by 8-32% per month, reducing the carbon footprint, extending service life of the expensive power equipment.

Case: Digital Power Supply



Location: western regions of Russia.

Problem: serious disagreements on consumption volumes, long data harmonization, high transaction costs and significant receivables between grid and sales companies.

Solution: trusted information environment based on blockchain technology and smart contracts, automatic meter reading, algorithms for calculation, splitting, arbitration between suppliers and consumers of resources.

Effect: 100% data reliability and accuracy of calculations based on the data, 20% reduction in OPEX for accounting, calculations and disputes settlement, 10-35% reduction of receivables between grid and sales companies, possibility of building up additional services for consumers (green tariffs, etc.).

Case: Smart City District



Location: central regions of Russia.

Problem: creation of a new city district with strict requirements for reliability, quality and efficiency of electric power, heat and cold supply.

Solution: creation of a city district-scale energy community with distributed sources of electric energy (including RES-based) and heat (including heat pumps), distributed sources of energy flexibility (energy storages, controllable load) with a common intelligent control system.

Effects (expected): reduction of capital and operating costs (by 20-30%) relative to the cost level of the old (traditional) solution.

The Energynet Partnership **offers** the interested BRICS countries

1. Solutions for smart management of consumption and utility resources in commercial buildings, in apartment buildings connected to the city power grid
2. Solutions for organization of subscriber energy services based on distributed registries
3. Designing of energy communities connected to the city power grid, local energy markets and their management systems.

Electric Mobility in Transportation, Industry and Agriculture Development

One of the signs of our times is a sharp growth of electric mobility that is transition to “wireless” electric power sources of moving vehicles and devices. This trend is most prominent in the transportation field: urban transport, personal cars, boats and river vessels, small aircraft and unmanned aerial vehicles, special, construction and agricultural machinery are being converted to electric traction. However, secondary electrification and electric mobility are also becoming increasingly relevant in industry, logistics, and agriculture as they become robotized. This trend is very critical for the BRICS countries, which are solving the problems of transport connectivity of large areas, urban development, new industrialization, agriculture efficiency enhancement and food security. The analysis results show that the market of BRICS electric mobility will be around $14.0 billion in 2035.

As the electric mobility solutions lose out so far in most cases in terms of catalog purchase price to the solutions based on traditional internal combustion engines, the main objective is to reduce the cost of ownership of electric vehicles and mobility systems, and it primarily depends on the development of energy storage and generation technologies embedded in the mobile device. One more limitation to the development of electric mobility is lack or underdevelopment of charging infrastructure and refueling systems for alternative fuels. The general objective is to ensure an effective integrated transition to electric mobility in the area.

To achieve these objectives, it is recommended to follow an approach to balance battery and hydrogen on-board power sources both within a single mobile system and across a fleet of different mobile devices, as well as to apply platform solutions for charging infrastructure management.

The main technological trends in the electric mobility development are:

- Increasing the power density of energy sources and the density of on-board energy storage, in particular through the use of hydrogen fuel cells
- Hybridization of different sources on board a mobile device and use of intelligent control systems for them
- Development of electric charging technologies for mobile systems
- Creation of digital models and decision-making systems in terms of charging infrastructure management.

Case: Development of National Programs for Transition to Electric Mobility



Location: one of the Transcaucasian countries.

Problem: economically optimum development of electric charging infrastructure and power grid to support the transition to electric mobility.

Solution: analyzing the market and regulatory environment, developing economic and technical models, preparing proposals for creation of a national digital electric mobility platform, developing a policy and a large-block investment plan.

Effects (expected): optimized investment plan with regard to development of public-private partnership mechanisms.

Case: Electric Charging Station Management System

Location: central and eastern regions of Russia.

Problem: today, Russia is actively developing the infrastructure of electric charging stations (ECS), but the problem of maximizing the use of geographically-distributed ECS to ensure return on investment and increase profitability remains.



Solution:

- creating a convenient management system for ECS owners that allows them to connect and manage electric charging stations (turn on, turn off, customize and collect diagnostic information), maintain user profiles, manage payments (including through tariff policy, subscriptions and promo codes), and carry out analytical activities

- providing a user application for car users to find the nearest station, view the status of the power station, available connector type, pay for charging via phone and monitor the charging process in real time.

Effect: increasing the use of the geographically-distributed ECS by increasing the number of ECS users and their optimal distribution among different stations. Increasing user friendliness by developing a marketplace of services for car users based on a user application, introducing a green tariff for electric car users, etc.

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Case: Hydrogen Testing Ground for Development of Electric Mobility



Location: Far Eastern region of Russia.

Problem: economically feasible transition to hydrogen technologies in transportation and other electric mobility applications.

Solution: creation of a hydrogen testing ground for implementing the pilot projects aimed at validation and economic evaluation of hydrogen technologies used in urban and railway transport, special urban vehicles, as well as mobile means of power supply applied in emergency situations.

Effect (expected): providing solutions for transition to electric mobility through the hydrogen technologies at a reasonable price.

The Energynet Partnership **offers** the interested BRICS countries

1. Feasibility simulation to implement national programs and projects for transition to electric mobility
2. Supply of ultra-fast charging stations for electric vehicles and electric buses
3. Supply and development of a control system for electric charging stations
4. Development of an open access platform for the national electric mobility management information system
5. Creation of experimental testing grounds for studying and demonstrating new technical solutions in the electric mobility field (including those based on hydrogen technologies).

SCIENCE AND EDUCATION AS THE BASIS FOR MUTUALLY BENEFICIAL COOPERATION

Cooperation among the BRICS countries shaping and realizing their vision of a fair, balanced energy transition must be based on the foundation of advanced, open to international cooperation science and innovative education. A major success has already been achieved in these areas. Student exchanges and joint research have become a daily practice, contributing to distribution of advanced knowledge and best practices, as well as increasing intercultural understanding. The developed and implemented joint training programs and scientific projects allow solving more complex and comprehensive scientific problems and attracting new ideas and approaches.

Still, the potential for cooperation in this area is far from exhausted, and its prospects within the BRICS are huge. The members of the association have extensive resources and a great potential in various subject and practice areas which allows creating favourable conditions for cooperation and joint innovation. The developed digital education, created joint research centers and promoted innovation may become key trends of cooperation in the near future.

The main focus of cooperation in science and education must be joint system research in the field of power industry transformation and its impact on development of economy and society in the developing countries, creation of testing grounds for testing and demonstration of new technologies and their components, implementation of innovative pilot projects, intensive development of competencies of new generation engineers.

The following new power industry initiatives are proposed to address the above tasks:

1. Conducting joint system research and developing national or international program and strategy documents
2. Establishing an international network of innovative scientific and educational EnergyNet.Lab hubs
3. Creating a network engineering school to train new generation engineers.

System Research and Development

The BRICS countries should develop a joint integrated approach to implementing a fair, balanced energy transition for the developing world. For this, they need to analyse a set of issues related to finding the balance between climate commitments and economic development in different BRICS countries and other developing economies, identify basic ideas of a fair, balanced energy transition for developing countries, outline steps to detail and implement this approach in the policies of the BRICS countries, and study the best practices in implementing such an approach.

Nowadays, Future Power Grids Center “EnergyNet” is successfully operating in Russia. The Center conducts analytical research on new markets, technologies and practices in the power industry, develops national and corporate program and strategy documents, supports and structures complex innovative projects. The “EnergyNet” Center in cooperation with its partners conducted research works in different countries of the world: Russia, United Arab Emirates, Singapore, Azerbaijan.

It is proposed to conduct a series of analytical research and expert discussions on various aspects of energy transition planning related to determination of economic and social benefits from the change in technological structure in the power industry with the expert and methodological support of the “EnergyNet” Center on the basis of the BRICS Energy Research Platform. In addition, the “EnergyNet” Center is open to cooperation on the practical implementation of the BRICS countries' approach to a fair, balanced energy transition.

Energynet.Lab Innovative Hubs

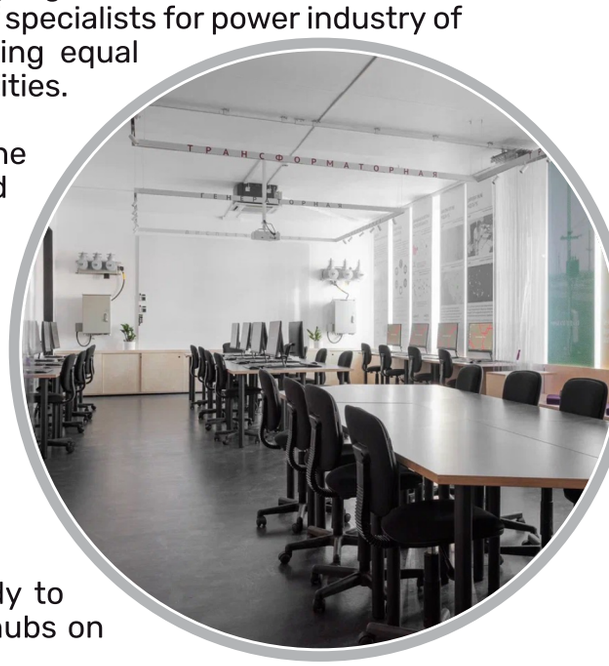
Establishing of the international network of innovative scientific and educational hubs in the field of intelligent distributed power systems will provide for rapid distribution and implementation of new knowledge, technologies and practices in the BRICS countries.

Energynet.Lab hubs are established on the sites of national universities, where, with the support of national partners and Energynet Partnership, research and development are carried out, testing grounds for new equipment and systems are created, digital simulation works are performed, engineering of innovative solutions is carried out, and training in new technologies and practices is conducted. These hubs have already been created in several technological universities in Russia, Belarus and Kazakhstan. Negotiations are underway to establish a scientific and educational center with a hydrogen testing ground at Khalifa University (Abu Dhabi, UAE).

Case: Energynet.Lab Knowledge Factories

Location: Russia, Belarus, Kazakhstan

Problem: the power industry of the future is in dire need of new personnel. The pace of technology development is ahead of educational programs. At the same time, the number of world-class experts involved in training of specialists for power industry of the future is limited, which does not allow providing equal access to knowledge to students at different universities.



Solution: creation of an innovative hub - the Energynet.Lab laboratory for simulating distributed intelligent power systems of the future. The laboratory is a state-of-the-art educational space in the co-working format, it is equipped with advanced computer and multimedia equipment with installed custom-made software. Students can be trained on the basis of Energynet.Lab within the framework of network educational programs in the areas of power industry of the future by integrating the laboratory with the Energynet.University network engineering school.

If the BRICS countries are interested, we are ready to offer them cooperation in creating Energynet.Lab hubs on the basis of national universities.

Energynet.University Network Engineering School

Cooperation in the field of new power industry is one of the most important factors for sustainable development. But, it is not enough to create technologies, it is also necessary to bring them to industry practices: smart grids, microgrids, energy storage systems, smart energy consumption, charging infrastructure for electric vehicles.

The Energynet Partnership follows the decisions taken by the BRICS countries regarding development of such educational projects such as BRICS University and BRICS SKILLS report. Within the framework of these projects, an initiative to expand the Energynet.University Network Engineering School based on a specialized ontology platform is proposed for practical implementation.

Objectives of Energynet.University Network Engineering School:

- Development of training courses based on the analysis of experience in implementing new energy technologies and practices
- Adaptation of training courses to the interests and industry specifics of the BRICS countries
- Launch of training courses in the national languages of the BRICS countries.

Training courses on the following topics have been prepared with the participation of industry specialists and Energynet Partnership experts:

1. Machine learning in the power industry
2. Cyber security in the power industry
3. Operation modes of distributed generation facilities
4. Engineering ontology
5. CIM in electric power industry
6. Digital area of power grid
7. Optimized simulation of fuel-and-power sector systems and components
8. Unmanned aerial vehicles application in the power industry
9. Hydrogen power industry and hydrogen economy
10. Chemical current sources
11. Electrochemical energy sources and hydrogen power industry
12. “First Element” engineering and sports competitions.

Students' competencies are improved by integrating relevant theory and practical tasks based on the projects of leading companies in the industry. The courses are adapted to the different educational structures of higher education institutions and materials are constantly updated. Using an ontology platform significantly reduces the time and efforts required to acquire new skills.

We suggest to start with a joint launch of course “What is a digital distributed network and how to implement it”, which has already been successfully piloted in 10 universities, and further develop a platform including other world-class courses.

Information and Analytical Review

ENERGY OF BRICS COUNTRIES:
ENERGY PRACTICES FOR ECONOMIC DEVELOPMENT

Reporting Project Manager D.V. Kholkin