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ON THE ISSUE OF SCENARIO APPROACHES TO THE DEVELOPMENT OF THE ENERGY SYSTEM

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ABSTRACT

The article analyzes scenario approaches to the development of the energy system of the world, as well as agreeing on the positive and negative sides, and proposes practical mechanisms to improve the efficiency of the energy system of the NKR.
Modern models of energy development are presented in the article, of which 6 are mainly used. The necessity of using the SCANNER model to improve the efficiency of the energy system of the NKR is especially emphasized, because it is as close to reality as possible.

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Activities in the energy sector have large and widespread environmental and social consequences. In this sense, to calculate the value of the latter, various models of energy system development are developed and applied in practice, differing from each other in the way they are applied, the cause-effect relationships, and the ability to predict them in the future.

In terms of improving the efficiency of the energy system, models are used that consider about 98 indicators in 10 groups:[1]

1. global context,
2. primary energy resources,
3. final energy resources (total, by industry, by sources,
1. energy production (by sources),
2. installed energy production capacity (by sources),
3. environment,
4. energy security,
5. social justice and access to modern energy sources,
6. technologies,
7. ensuring energy efficiency.

Table 1 presents modern models of development of the energy sector, which are classified according to different criteria. Moreover, 6 models (which cover a wide regional coverage) are used in different countries to develop and implement scenarios for the development of the energy sector according to specific objectives and period.

[1] International Institute for Energy Policy and Diplomacy // MSIIR-University: Traditions and Modernity. 1944–2014. / Under the editorship of RAS Academician A.V. Torkunov: MSIIR-University, 2014. 175–184 pages

Table 1. Current models of energy sector development (forecast)[1]

Classification standards	MARKAL	WEM	PRIMES	SCANNER	POLES	NEMS
Approach	increasing	y	decreasing	y	y	y
Used in forecasting	Global Energy Scenarios. (The future of the energy system until 2050)	OPEC (World oil outlook) World Energy Outlook)	Tendencies in energy, transport and greenhouse gas emissions in the EU until 2050.	World and Russian energy perspectives until 2040.	Perspectives on Global Energy, Technology, and Climate Policy, EU	Annual energy outlook with projections until 2040
Period	More than 80 years	25 years	35 years	More than 15 years	More than 25 years	More than 25 years
Step	0 years	5 years	5 years	5 years	10 years	10 years
Regional coverage	World, 8 regions	World, 17 regions, 3 regional groups, 12 countries	World, 9 regions, 7 sub-regional groups, 2 countries, 5 specific country groups	World, 62 large countries, 83 regions of the Russian Federation	World, 7 regions, 3 sub-regional groups	National level (USA)
Production purpose	Production (mining), transport, marketing, consumption, CO2 emissions	Production (mining), sale, emissions of consumable pollutants	Investment, production (mining), transport, marketing, consumption, pollutant emissions	Investments, production (mining), transport, marketing, consumption, CO2 emissions	Production (mining), marketing, consumption, CO2 emissions	Production (mining), transportation, sale, consumption, pollutant emissions
Number of primary sources of energy considered	15 followed by comparison of 7 groups according to the method	7	11	Provides the ability to include more than 20 sources in the model	12	7 groups (no reliable data on the structure

y - the application of the model depends on the tasks and approaches to the solution

A preliminary review of the energy scenarios makes it clear that the results of each are based only on assumptions, expert opinions, and some assumptions.[2] Therefore, the quantitative estimates of the latter differ significantly from each other. At the same time, their qualitative estimates often coincide, which cannot be said about the predictive values, since when using the same model, the predictive values differ significantly among the countries that make up the regional coverage.[3]

When choosing any model, the forecasting process includes:

- the dynamic changes in indicators over time and initial data characterizing a specific state of the system,
- expert assumptions.

That is, in the process of forecasting, the lower levels of the hierarchy are evaluated (bottom-up approach). In its turn, the construction of scenarios of energy system development includes the study of several options, as well as the assessment of factors affecting the industry (top-down analysis).

[1] Subhes C. Bhattacharyya, Govinda R. Timilsina. Energy Demand Models for Policy Formulation. The World Bank Development Research Group, Environment and Energy Team. Available at: http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-4866 (Accessed 31.05.2022)

[2] David L. Greene. Long-term Energy Scenario Models: A Review of the Literature and Recommendations. Oak Ridge National Laboratory. Available at: http://www1.eere.energy.gov/ba/pba/pdfs/models2050.pdf (Accessed 31.05.2022).

[3] Litvinyuk I., Elzinga D. Setting the stage for future sustainable energy systems. Geneva: UN Special, 2015, no. 751, p. 28

Hypotheses construction and determination of required parameters are carried out with the help of economic and mathematical models, which consider indicators that are often similar in their qualitative interpretation, but have different quantitative assessments.

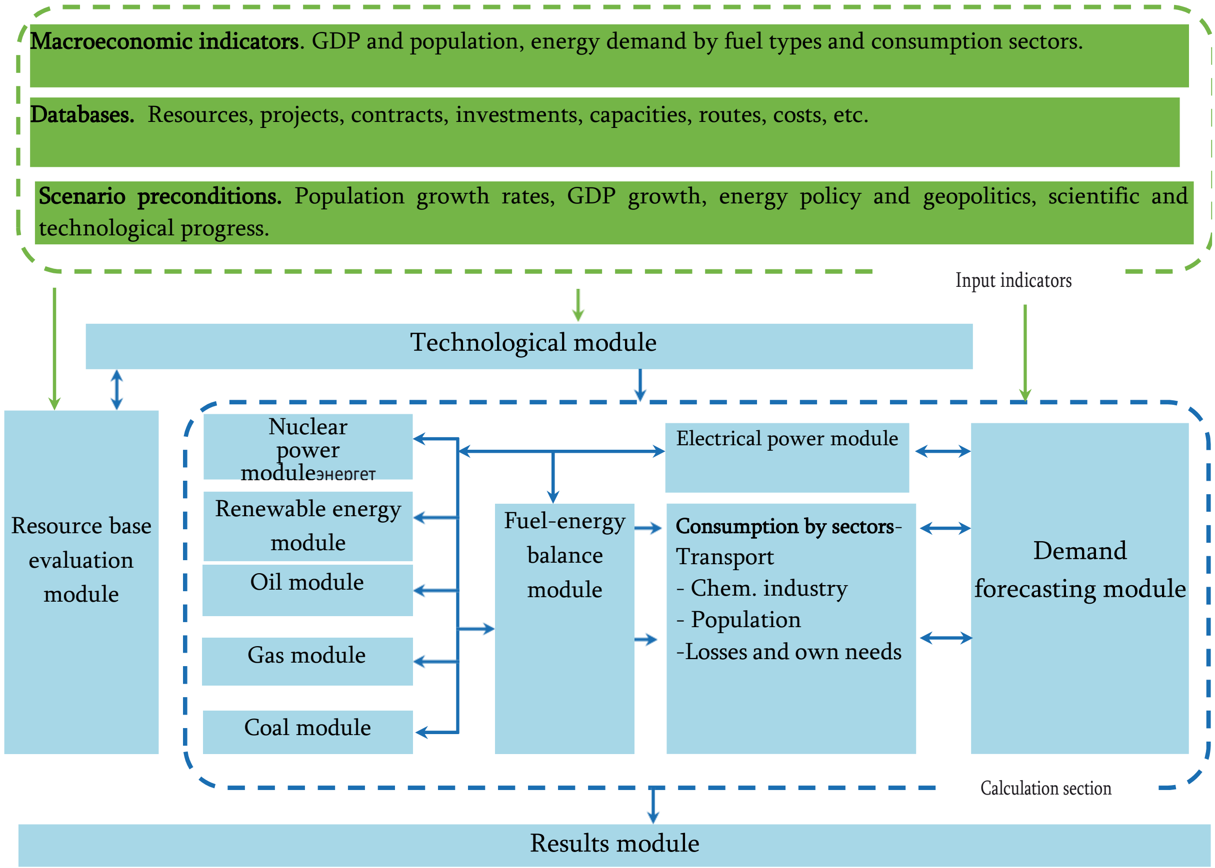

Fig. 1. SCANNER model structure and operation format [1]

We especially highlighted the SCANNER model, which can be used for further development of the NKR energy sector. Moreover, the SCANNER model has gained wide popularity in more than 62 countries of the world, as well as in Russia.

The SCANNER model has been used for more than 15 years; in particular, more than 20 indicators have been identified in 5 years to develop a strategy for energy system development and forecast implementation.

In accordance with the strategic objectives of the development of the energy systems of different countries, the production goals of the SCANER model were agreed upon: investment, production (production), transport, marketing, consumption, CO2 emissions (Table 2).

According to Fig.1, the structure of the SCANER model consists of 3 sections:

1. The "Historical Indicators" section includes indicators characterizing the macroeconomic and energy system (GDP and population, energy demand by fuel type and consumption sector), technological indicators (Resources, projects, contracts, investments, capacity, routes, costs), and scenario preconditions (population growth rate, GDP growth, energy policy and geopolitics, scientific and technological progress).

2. The elements characterizing the energy sector are included in the technology module, from the assessment of the energy resource base to the forecasting of industry demand and its assessment.

3. The output module applies best-case approaches, which are then translated into energy policy.

The SCANNER model is as close to reality as possible, as it allows us to consider different combinations of criteria and priorities in the search for solutions, to study the sensitivity or calculate

[1] Sources: ERI RAS, Moscow School of Management SKOLKOVO Energy Center

the degree of risk in decision-making. With the latter, it is possible to identify rational options that contribute to the development of the energy sector, rather than formally or optimally. Then there is the opportunity to develop development scenarios, of which the most sustainable and consistent economic development scenarios are applied, taking as a basis the future trends of economic development, the structure of the energy market and the external and internal factors affecting it, the rate of technological progress and the possibilities of their application and the degree of risk.

- The choice of scenario approaches to the development of the energy system predetermines the energy policy, and the increase in its efficiency is due to the following:
- prices for fuel and energy resources,
- the choice of policy instruments,
- the level of technical progress and the possibility of investment,
- the demand for energy resources and services.

According to the International Energy Agency, the World Energy Outlook (WEO) report has used scenario approaches to energy system development extensively in various countries. It explores different scenarios, each based on different assumptions, in order to figure out: how the energy system might evolve. These scenarios are not predictions, and the International Energy Agency has never had a consensus on what long-term results the energy system can achieve. Instead, however, the latter develops different scenarios, the comparison of which and the subsequent selection of some of them allow the global energy system to move forward and apply a more effective strategy.

Thus, the report "World Energy Outlook 2021 (WEO-2021)" developed four scenarios of energy system development, which were used in different countries:

1. "Emissions Zero Net by 2050 (NZE)",
2. "Announced Promises (APS)",
3. "Announced Policies (STEPS)",
4. "Sustainable Development (Scenario)".

Table 2. Contents and problems of the four energy system development scenarios according to the World Energy Outlook 2021 report[1]

Differentiation criteria	"Net zero emissions by 2050 (NZE)" scenario	"Announced Promises (APS)" scenario	"Announced Policies (STEPS)" scenario	"Sustainable Development (Scenario)" scenario
Contents	A scenario that sets a narrow but achievable path for the global energy sector to achieve zero CO2 emissions by 2050. It does not rely on emissions reductions outside the energy sector to achieve its goals.	A scenario that assumes that all climate commitments made by governments around the world, including nationally determined contributions (NDCs) and long-term zero net pollution targets, are met in full and on time.	A scenario reflecting current policy parameters, based on an assessment of specific existing policies by sector, as well as policies announced by governments around the world.	A built-in script defining the path to: significantly reduce air pollution (SDG 3.9); and take effective measures to combat climate change (SDG 13).
problem	Show what different actors in key sectors need and what the deadline is for achieving full zero CO2 emissions from energy and industrial processes by 2050, while meeting other energy-related sustainability goals.	To show how close current pledges are to the global goal of limiting global warming to 1.5°C, it highlights the "Ambition gap" that needs to be closed to meet the targets agreed in Paris in 2015.	Provide a benchmark for assessing the potential benefits (and limitations) of recent changes in energy and climate policy.	At the same time, to show a possible way to achieve universal access to energy, to point the way to achieving the goals of the Paris Agreement on climate change and to significantly reduce air pollution.

[1] https://www.iea.org/reports/world-energy-model/understanding-weo-scenarios

As the results in Table 2 show, the scenarios emphasize the importance of public policy in projecting the future of the global energy system. Moreover, the decisions made by governments differ depending on the scenarios applied and the results obtained (economic and demographic, technological costs, energy prices and availability, corporate sustainability according to commitments, and socio-behavioral factors). [1]

Conclusions. Studying the scenario approaches of energy system development and application of different models in the world, as well as coordinating the positive and negative sides, it was proposed to apply these models in the NKR, as well as to develop development scenarios aimed at improving the efficiency of the energy system.

The infrastructure of the energy sector determines the need for reforms in a given country, that is, the greater the market structure, the greater the country's potential for developing the energy sector, and the more efficient the market mechanisms, the less dependent the energy sector is on politics.

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[1] APERC. Energy security initiative: Some aspects of oil security. Energy security initiative / APERC. – APERC, IEEJ, 2003. – 60 p.