THEORETICAL ASPECTS OF THE USE OF ARTIFICIAL INTELLIGENCE IN POWER GRID SYSTEMS

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Abstract: *the article discusses the growth trends in the fields of generation and consumption of electricity in the Russian Federation. The issue of transition of the energy sector to a new intellectual technological base is acute, which allows us to talk about the structural and technological crisis in the energy sector, further technological development is fundamentally impossible with the continuing structure of the electricity market. Key changes in energy consumption patterns will be accompanied by a sharp increase in demand in the context of the impending environmental and resource crisis, which will require the development of alternative energy technologies.*
The most promising way to overcome the structural and technological crisis in the energy sector - the construction of interconnected self-organizing intelligent systems (is). In intelligent networks, the tasks of risk assessment and management and coordination of interests of many subjects of the energy system come to the first place.
Keywords: *smart grids, neural networks, intellectualization, energy infrastructure.*

ТЕОРЕТИЧЕСКИЕ АСПЕКТЫ ИСПОЛЬЗОВАНИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ЭЛЕКТРОСЕТЕВЫХ КОМПЛЕКСАХ

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Аннотация: *в статье рассматриваются тенденции роста в областях генерации и потребления электроэнергии в Российской Федерации. Остро стоит вопрос перехода энергетической отрасли на новую интеллектуальную технологическую базу, что позволяет говорить о структурно-технологическом кризисе в энергетике. Дальнейшее технологическое развитие принципиально невозможно при сохраняющейся структуре рынка электроэнергии. Ключевые изменения структуры потребления энергии будет сопровождаться резким ростом спроса в условиях надвигающегося экологического и ресурсного кризиса, что потребует развития технологий альтернативных источников энергии.*
Рассмотрен наиболее перспективный способ преодоления структурно-технологического кризиса в энергетике – построение взаимосвязанных самоорганизующихся интеллектуальных систем (ИС). В интеллектуальных сетях на первое место выходят задачи оценки и управления рисками и согласование интересов множества субъектов системы энергетики.
Ключевые слова: *умные сети, нейронные сети, интеллектуализация, энергетическая инфраструктура.*

Today, energy is on the threshold of the neoindustrial stage of development, the main trends of which should be quantitative and qualitative growth in the fields of generation and consumption of electricity, as well as further globalization and at the same time regionalization of energy [1, p. 9].

The knowledge and developed technologies accumulated over the last decades require qualitatively new approaches and ideology to the development of energy for their comprehensive application.

There will be a revolutionary situation when the energy industries cannot cope with the challenges they face without the transition to a new intellectual technological base (ITB), and the aging infrastructure, designed for a rigid hierarchical structure and limited by the narrow framework of the sectoral approach, does not allow for the much-needed technological transition. This allows us to talk about the structural technological crisis in the energy sector, when further technological development is fundamentally impossible with the remaining structure [2].

An important fact remains that the change in the structure of consumption will be accompanied by a sharp increase in demand in the context of the impending environmental and resource crisis, which will require the development of alternative energy technologies. But while maintaining the outdated ideology and infrastructure of the industrial stage of development, primarily designed to supply the production giants, the transition to the above technologies is impossible [3, p. 6].

Obviously, a new energy ideology and infrastructure are needed to overcome the structural and technological crisis.

Taking into account the experience of the development of information networks over the past decade and development trends, the main properties of the energy infrastructure of the future should be:

• network architecture;
• intellectualization;
• multi-agent control;
• active adaptation (self-organization);
• sectoral integration;
• scalability;
• connectivity to the global information space;
• convenience as a socio-psychological criterion for the end user.

One of the most promising ways to overcome the structural and technological crisis in the energy sector is the construction of interconnected self-organizing intelligent systems (is) [4, p. 16]. Using such systems, it is possible to integrate all available technologies and concepts and, at the same time, to overcome the limitations of a narrow sectoral approach, which gives hope for the emergence of qualitatively new effects. It is the emergence and interaction of such systems that will allow us to talk about the new energy of the XXI century.

The smart grid should be seen as a continuation of the smart grid (Fig. 1). Their main differences are in the structure and dynamics of development.

In an intelligent network, the tasks of risk assessment and management and coordination of interests of many subjects of the system come to the first place, while the "smart" network solves the problems of dispatching and dispatching management in a strict hierarchical structure. The consequence of the increase in the objects of management and their various relationships, primarily due to the development of distributed generation, which will require redistribution to the lower levels of responsibility in the system and, accordingly, its intellectualization.

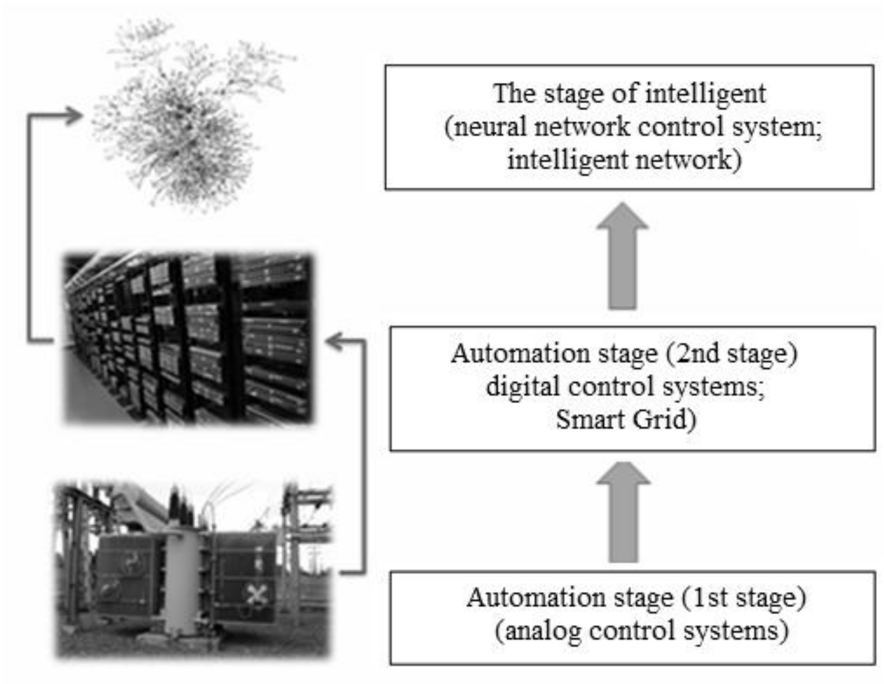

Fig. 1. Stages of development of management systems

Today, according to [3, p. 9], it is customary to talk about two approaches to the creation of artificial intelligence:

• semiotic (top-down), aimed at building expert systems and knowledge bases that simulate high-level mental processes (reasoning, thinking, speech);

• biological (ascending), aimed at building artificial intelligence (AI) systems, including distributed (swarm intelligence, etc.), modeling intelligence based on biological elements.

The semiotic approach can be successful at the stage of "smart" networks in a strict hierarchical system, mainly for the construction of decision support systems. Consequently, the biological approach that simulates the behavior of complex biological systems, represented by artificial neural networks and evolutionary algorithms, comes to the fore. Taking into account the constantly changing environment and structure, the main task, in our opinion, will be the task of machine learning, which gives artificial neural networks (Ann) an undeniable advantage [5, p. 11].

Neural networks are not programmed, but are trained from the original data set. The possibility of learning is one of the main advantages of neural networks over traditional algorithms. Technically, the training consists in finding the coefficients of connections between neurons. Ins are used to solve problems of classification and pattern recognition, optimization, forecasting and automation.

The transition to a "smart" network based on advanced network Analytics, automated control of metering devices, remote monitoring and control of equipment, management of mobile human resources and the use of modern SCADA systems operating through IP, will help network companies to extend the life of equipment, prioritize equipment replacement, postpone expensive network updates and prevent network failures [6, p. 32].

Table 1.1. Technical parameters of traditional and intelligent networks

Management and monitoring systems	Traditional	Management and monitoring systems
Backbone backbone transport networks		
Systems for evaluation of the current state (mode) of power lines	Passive	Active
The system of automatic control of the transmission line with the results of control actions for her discharge	Manual control	Automatic control
The system of automatic control of stresses at the control points of the transmission line and mode control voltage	Manual control	Automatic control
The distribution network for General use		
Automatic control system of active and reactive power node balance	Slightly	Universally
System of control and management of quality of electric energy in network nodes	No	Yes
System of centralized automatic control of load of consumers	No	Yes
System assessment of the current state (mode) of the network	No	Yes
Availability of managed network elements that change network settings	No	Yes
Consumer networks		
Automated system of electricity consumption accounting	Extremely insufficiently	To the extent necessary
Voltage regulation and reactive power compensation system	Extremely insufficiently	To the extent necessary
Local (reserve) sources of generation	Practically absent	Wide application of small generation + power storage
Availability of communication interface with a single control center	No	Yes
Intelligent energy-saving technologies in power supply systems ("smart house"; "smart city»)	No	Yes

In any case, the smart grid is designed to enable grid energy companies to provide better services without dramatically increasing prices, as well as to be the first step in building new energy infrastructure.

Conclusion:

1. The factors influencing the use of artificial intelligence elements in power grid complexes are presented.
2. It is revealed that one of the most promising ways to overcome the structural and technological crisis in the energy sector is the construction of interconnected self-organizing intelligent systems.
3. Transition to work on the principle of "smart" network in the Russian Federation, based on the improvement of network Analytics, automated control of metering devices, remote monitoring and control of equipment, management of mobile human resources.
4. It is determined that the main advantages of the ins in forecasting is the collection and processing of data without time constraints, the ability to obtain data directly from the EPS, as well as the ability to take into account a variety of parameters that do not consist in functional communication.

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