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Application of a risk-oriented approach in the process of professional training of specialists in energy industry

Abstract. *The article highlights the current issues of improving the professional training of future specialists of energy industry in the conditions of growing risk and instability in the energy sector. The need to adapt educational programs and methods to take into account modern technological innovations, economic factors and environmental challenges is substantiated. A risk-oriented approach is proposed as a key element in the identification and management of the risks, associated with energy activities. Special attention is paid to the integration of practical simulations and tests that reproduce real risk scenarios into the educational process.*

Streszczenie. *W artykule zwrócono uwagę na aktualne zagadnienia doskonalenia kształcenia zawodowego przyszłych specjalistów branży energetycznej w warunkach rosnącego ryzyka i niestabilności w sektorze energetycznym. Argumentuje się potrzebę dostosowania programów i metod edukacyjnych, aby uwzględnić nowoczesne innowacje technologiczne, czynniki ekonomiczne i wyzwania środowiskowe. Proponuje się podejście zorientowane na ryzyko jako kluczowy element identyfikacji i zarządzania ryzykiem związanym z działalnością energetyczną. Szczególną uwagę zwraca się na włączenie do procesu edukacyjnego praktycznych symulacji i testów odtwarzających rzeczywiste scenariusze ryzyka.* (***Zastosowanie podejścia zorientowanego na ryzyko w procesie kształcenia zawodowego specjalistów branży energetycznej***)

Keywords: energy industry, educational program, professional training, risk-oriented approach.
Słowa kluczowe: branża energetyczna, program edukacyjny, szkolenia zawodowe, podejście zorientowane na ryzyko.

Introduction

The issues of energy saving and energy efficiency become more and more relevant every year. This is due to several key factors, namely. the shortage and constant reduction of natural resources, the increasing requirements regarding energy security of Ukraine, high energy consumption of the national economy, as well as the annual increase in the prices of imported energy resources, such as coal, gas, oil and nuclear fuel rods. In addition, it should be noted that losses in energy systems caused by hostilities were added to the problem of energy saving and energy efficiency.

One of the ways to overcome the crisis situation is to ensure the quality of professional training of future specialists at higher education establishments. In order to define the educational strategy in the specified direction and its implementation, Ministry of Energy, Ministry of Education and Science, as well as the National Joint Stock Company "Naftogaz of Ukraine" in 2022 signed a memorandum on cooperation in the educational, scientific and technical sphere with a number of leading higher educational institutions. which train specialists for oil and gas industry. Within the framework of the mentioned memorandum, cooperation in the following directions is envisaged:

– improvement of higher education standards and educational programs for training future industry specialists;

– development and implementation of joint educational projects between domestic and foreign higher education institutions;

– support of scientific, technical and innovative activities of higher education institutions, promotion of their integration in the production sphere , etc.

In addition, the implementation of the ISO 50001 "Energy Management Systems" standard, the adoption of the Law of Ukraine "On the Electric Energy Market" No. 2019-VIII (as amended on January 26, 2024) [15] and the development of the Smart Grid concept in Ukraine provide the emergence of new increased requirements for training specialists in the field of electrical engineering. Therefore, modern specialists in the energy industry must not only be competitive, but also be able to work in conditions of a high level of stress, often in extreme conditions, in a changing environment, think broadly and responsibly for the consequences of their work.

Literature Review

The problem of training future specialists in the field of power industry and ways to ensure its quality is quite urgent, which is confirmed by a number of publications in leading scientific editions. Thus, J. Mitchell and other researchers [11] emphasized that the professional training of qualified specialists involves not only the mastering of narrow-profile disciplines, but also the development of a wide range of knowledge and skills: from technical, scientific and mathematical knowledge to the ability to communicate productively, work in a team and think critically. This approach requires a thorough selection of pedagogical methods, taking into account the digitalization of modern social life. We agree with the authors that it is vital that training is based on real production situations and examples. Similar approach to professional education is demonstrated by J. Herrington [7].

According to A. Roudaut [13], it is time to review the principles of teaching and training of future specialists in technical specialties, in particular in the direction of implementing the existing technical innovations. The scientist believes that students participation in the solution of real research problems is an effective way to implement such an approach. She demonstrated this approach, its advantages and characteristic features in the publication.

Certain methodological issues regarding the improvement of professional training of future specialists in technical specialties are covered in the publications [4, 5, 8, 14], and problems of digitalization of the educational process are presented in the studies [3, 6, 10, 12].

Summarizing the available publications on the research problem, we state that the improvement of the content of the training of future specialists for the energy industry the following factors should be taken into consideration:

1) operation of energy systems with a gradual transition to renewable sources of energy. Growing public awareness of the irreversibility of climate change and the depletion of traditional energy sources is accelerating the transition to renewable energy sources. Future specialists should be prepared for the effective implementation of projects related the use of solar, wind and other alternative energy sources. At the same time, they should be aware of all possible risk factors;

2) focus on technological development: The rapid pace

of technological development in the energy industry requires energy professionals to constantly improve their skills. The application of modern technologies, such as intelligent networks, energy storage and digital control systems, becomes the key task for the optimization of energy systems, and the understanding of the importance of an innovative approach must be formed among specialists at the stage of professional training;

3) the need to ensure energy efficiency and energy conservation. Awareness of the need to reduce energy consumption and optimize energy processes leads to the increase in demand for specialists who know how to implement energy-efficient technologies and develop energy conservation strategies. In addition, there is a steady demand for such specialists in society and this demand constantly grows. Therefore, the improvement of educational programs for the training future specialists for power industry should take into account this aspect;

4) the need to achieve global energy security. Provision of the stability and security of energy supply is a critical task for all countries of the world. Future energy engineers must be ready to solve energy security problems, be able to identify risks, available in this direction and determine the optimal ways to minimize them;

5) global challenges related to climate change. Climate change is currently one of the biggest threats to the planet. Future power engineers must understand the importance of minimizing environmental risks in the process of generating electric current and operating power systems.

In this regard, we believe that the training of future secialists in the sphere of power engineering is critical for ensuring sustainable development, reducing the impact on the environment, providing energy security in the world and higher education institutions are responsible for ensuring the quality of this training.

The Statement of Basic Materials

The activities of modern specialists in the field of electrical engineering are significantly different from the work of their colleagues of the previous generation, when the main emphasis on the part of employers and the state was aimed at meeting the immediate needs of the organization. They sought to avoid risks, adhering to the concept of achieving 100% absolute safety in the performance of any work and considered the employee as an interchangeable resource of the organization. The new social paradigm involves interaction between employees and the organization based on mutual support and the common goal of achieving high-quality and effective results. Rejection of a passive attitude towards employees as a means of achieving goals, in favor of promoting their professional growth and satisfaction from their own activities, is another important feature of the development of modern industry.

There exists a specific feature in the field of power generation, related to the immediacy of energy production and consumption, the complex technological cycle of its production, the need for centralized dispatching operational-technological management of the entire complex as a whole, as well as the need to ensure the reliability and safety of functioning. This makes power generation a sector that requires significant material, intellectual and scientific investments, with a long investment cycle. In the context of constant technological development, the power industry justifies its status as a material-intensive industry due to the constant need to improve and modernize power systems. A high level of automation and the introduction of innovative technologies makes the electric power industry not only intellectually capacious, but also such an object that requires the implementation of the concept of "smart" energy management. This branch of industry requires not only large investments, but also constant interaction between scientists, engineers and other specialists to achieve efficient and stable functioning.

Development of the wholesale electricity market and improving the price policy by creating conditions for the competition, the process of analysis and decision-making regarding its development provides the involvement of a number of participants with different interests. The presence of a significant number of market participants is a risk factor, since failure to fulfill certain obligations will lead to undesirable consequences, primarily economic losses due to disruption of the electricity supply mode. When developing a strategy and tactics for the behavior of participants in the electricity market, a systematic risk analysis is required, which includes risk management at all levels of decision-making. This, in its turn, presupposes the availability of relevant knowledge and skills, as well as a formed risk-oriented thinking among energy industry specialists.

The concept and content of risk-oriented thinking are defined in accordance with ISO9001:2015 "Quality management systems. Requirements" (ISO 9001:2015 "Quality management systems – Requirements", IDT).

The mentioned standard defines as the key purpose of the quality management system – to act as a preventive tool. That is, a specialist with risk-oriented thinking should be able to determine the method of risk assessment, guided by current regulatory documents and guidelines, predict possible consequences and develop ways to eliminate or reduce the risk itself before the onset of action. In order for the future specialist to develop appropriate skills, he must not only be aware of the existing risks, but also act in accordance with generally accepted risk management mechanisms. Fig. 1 shows the principle of risk-oriented thinking.

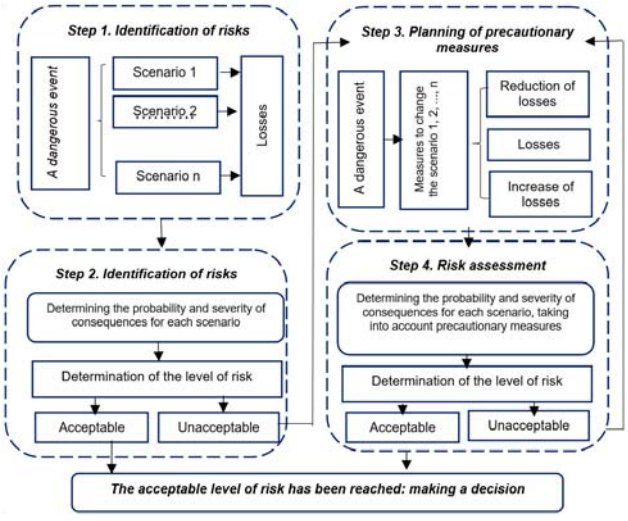

Fig. 1. The principle of risk-oriented thinking

To be able to identify risks, future specialists must determine exactly what risks exist and the scope of their impact. We highlight the following risks in power industry:

- risks associated with danger for human life, in particular natural environmental aspects, which is manifested in the practical absence of reliable and representative statistical data. This creates a situation where the objective assessment of potential negative impacts on people and the environment is complicated by the lack of sufficient information;

- production and technological risks, which determine the probable consequences of failures of technical systems and their components. This includes the possible consequences of problems or failures of elements of technical systems that may affect the efficiency and safety of energy systems;

– legal risks that arise due to the lack of an effective risk management mechanism based on current legislation. This means that existing regulations or legal frameworks do not define or provide adequate tools to effectively control and manage potential legal risks in the electricity sector, which may lead to insufficient regulation and increased legal uncertainty;

- financial and economic risks that may arise due to the lack of data on the real cost and technical condition of electrical equipment, as well as the practical impossibility of obtaining objective technical and economic information about the consequences of various types of accidents, damages and failures. This can lead to financial losses and uncertainty in resource planning, risk assessment and development of financial management strategies in the power industry;

– information risks, which contain potential dangers related to the protection of the information systems and data exchange in this sector (cyber attacks on information systems of electric power facilities, leakage of information that may lead to the leakage of commercial or technical data and create competitive advantages or constitute a threat to the security of the energy infrastructure, technical errors and malfunctions, which in the conditions of growing automation and the use of the Internet of Things can lead to major accidents or loss of efficiency of energy systems, etc.);

– commercial risks, which include aspects related to financial stability, competitiveness and efficiency of business processes, in particular market fluctuations (fuel prices or changes in the regulatory environment can significantly affect the profitability and financial condition of companies in the electricity sector), competitive pressure (new manufacturers or technologies can put pressure on prices and force companies to look for new strategies to remain competitive), excessive dependence on certain markets or customers, etc.

Mastering the content of these risks takes place during the study of safety disciplines and professional disciplines. At the same time, it is important that methodological approaches within each individual discipline are common. Only in this case the acquired knowledge will be systematic and integral.

At the initial stage of the study of risks in the electric power industry, we emphasize that the key aspect on which all other risk characteristics depend on and proceed is the probability of the interests conflict between different groups of energy market participants during the interaction (Table 1).

In addition, a specific feature of the industry is the impossibility of the rigid planning of production volumes, since production and consumption occur simultaneously and are determined by it. Volumes of energy generation depend entirely on the consumers and cannot be set according to the wishes of the producers. At the same time, the risk management system will acquire specific features (Fig. 2).

For future specialists in power generation industry, it is important to realize that there are currently several basic methods of risk management:

- avoid risks, that is, plan work so as not to get into a situation in which there is a high probability of risk and damage to the enterprise;

- recognize the risk that implies the establishment of a potential loss in the budget;

– share the risk with customers, suppliers, employees, etc.;

– with the help of corrective measures, reduce the probability of risk occurrence or minimize losses in case of risk occurrence;

– transfer possible risks to a third party, in particular to insure possible losses.

Table 1. Structure of the energy market

Subjects	Interests in the market	Conflict of interests
Power producers	maximization of the production and profit	increase of the production volumes vers environmental impact
Electricity distributors	maximization of the profit as a result of their activities, ensuring stability of supply	increasing tariffs that may burden consumers
Electricity consumers	tariff reduction, stability, quality of electricity and reliability of electricity supply	low quality of services, erratic supply
Regulators of the energy market	ensure the effective functioning of the market	conflict of interests between different market players
Authorities	maximization of revenues to the budgets of the relevant levels, energy efficiency and economic development	energy price fluctuations, energy security
External investors	minimization of terms of return of capital invested in electric power facilities, maximization of dividends	possible conflicts of interest between investors and internal market players

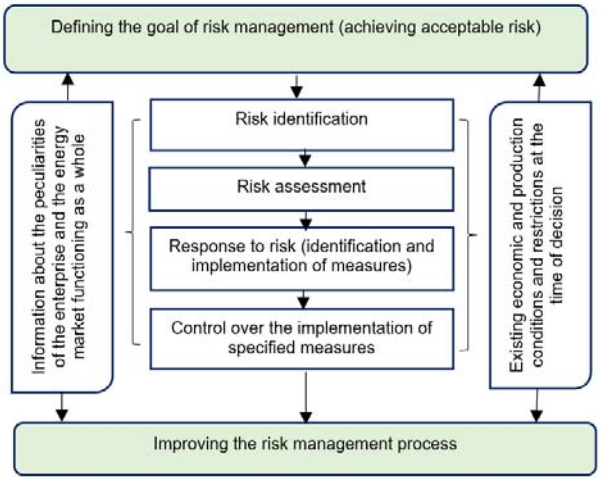

Fig. 2. Risk management system in energy industry

It is clear that the choice of one or another method will depend on a specific enterprise in the energy industry and the specific conditions of its functioning. For example, methods and measures to increase the efficiency, safety and reliability of operation of electrical installations are reflected in publications [1, 2, 9].

At the current stage of development of the energy sector, the electricity market is quite complex and unique from the point of view of financial relations. It differs significantly from traditional financial markets in a number of ways, and this, in its turn, complicates the development of effective mechanisms for minimizing existing risks.

We consider it necessary to draw students' attention to its following features:

1) heterogeneity and high variability. Modern electricity market is dynamic and subject to significant changes depending on various factors such as weather, seasonality, production and consumption levels. This leads to high variability of electricity prices and creates difficulty in forecasting market conditions;

2) substantial dependence on state regulation. The electricity market is significantly influenced by regulatory bodies and existing political decisions, for example, changes in energy strategies, implementation of new environmental standards, support for renewable energy sources, etc.;

3) specific physical parameters of the product (electricity). The energy market has its own characteristics related to the fact that electricity is a physical product that has its own physical parameters and requires specific conditions for supply, transportation and storage of the product;

4) a large number of participants and complex interaction with various industries. The electricity market includes a large number of participants such as producers, suppliers, regulators, consumers and intermediaries. The interaction between these groups makes it a complex management environment;

5) high technological dependence. With the introduction of modern technologies and automation systems, the electricity market becomes technologically dependent and vulnerable to cyber attacks and technical failures.

All of the above-mentioned factors require from energy market participants to develop and implement various risk management strategies to ensure the stability and efficiency of activities in the energy sector. Our proposed approach, taking into account all factors, is shown in Fig. 3.

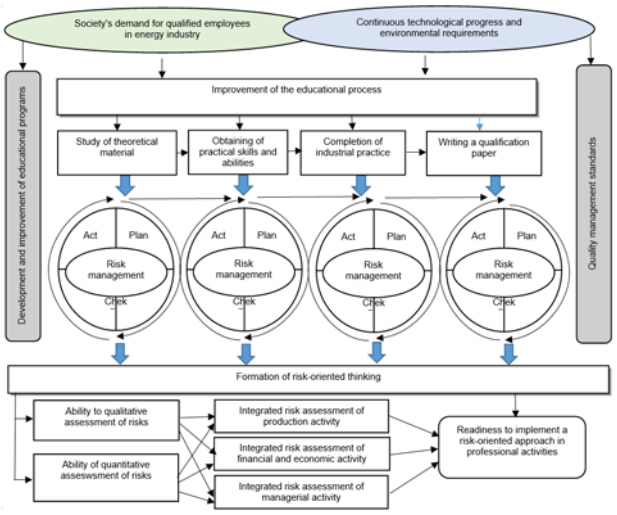

Fig. 3. Model of professional training improvement of energy industry specialists

Conclusions

Training of specialists for the needs of the energy industry involves the combination of the study of fundamental disciplines (higher mathematics, general physics, theoretical fundamentals of electrical engineering) with the study of professional components of the educational program (electrical machines, electrical systems and networks, reliability of electrical networks and systems) to form the ability to solve professional tasks in the course of labor activity. In this hierarchy, the problem of formation of risk-oriented thinking in professional training of the specialists in the sphere of power rngineering is quite urgent and requires improvement of forms and methods of professional training, introduction and use of personally-oriented technologies, as well as provision of positive motivation to acquire relevant skills and abilities.

The process of competence formation of future specialists in power generation industry should also be carried out under the condition of using modern regulatory framework on life safety and labor protection of the European Union, which will nhance their competitiveness on the modern labor market.

The authors analyzed the problem of improving the professional training of future specialists in the energy industry, paying special attention to the peculiarities of the risk-oriented approach in the activities of energy enterprises. It is noted that modern energy is constantly changing under the impact of technological innovations, economic factors and environmental challenges, therefore there is an urgent need to make changes to training programs and methods of training specialists that would take into account the instability of the modern energy environment. It is proposed to use a risk-oriented approach as a key factor for updating educational programs, taking into account its significance in the system of risk management related to energy activities. In particular, the need to integrate practical simulations and tests with real risk scenarios into the educational process is highlighted. The proposed recommendations outline prospects for further research and innovation in the vocational training system, taking into consideration the growing risks and instability in the modern energy sector.

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