

Methods for assessing the efficiency of innovation activity of enterprises of the electric power industry

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Abstract. The innovative basis for the development of the electric power industry is the basis for increasing the competitiveness of the economy as a whole. The purpose of the study is to develop a model for assessing the efficiency of innovation activity of enterprises of the electric power industry. The paper reveals a set of external macroeconomic factors that require adaptation of the innovation activity of the enterprise. A system of criteria for assessing the efficiency of innovation activity of enterprises of the electric power industry was developed. The approach to the selection of rational management decisions to improve the efficiency of innovation activity of enterprises of the electric power industry is substantiated. It assumes the choice of the reference enterprise based on the analysis of the state of innovation activity of the enterprise, as well as the assessment of the level and reserves of increasing the efficiency of innovation activity by group criteria.

1 Introduction

The innovation development of the domestic electric power industry is intended to ensure the passing of energy barriers of the country's economic growth, including by increasing the energy efficiency in the area of production, transportation and consumption, and expanding the use of alternative energy. The conducted studies have shown that innovation activity of the economic system is traditionally understood as the activity aimed at the commercialization of accumulated knowledge, technologies and equipment [1].

The essence of the assessment of the efficiency of innovation activity of the economic system is to determine the level and dynamics of the competitiveness of the economic system as a result of innovation activity.

2 Materials and methods

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The paper shows that the content of the assessment of the efficiency of innovation activity (IA) of the economic systems is determined by the feature space presented in Table 1.

Table 1. Signs of space determining the content of the assessment of the efficiency of innovation activity of the economic systems.

№	Feature	Components
1	Efficiency for the participants of innovation processes	Assessment of the efficiency of IA from the perspective of the manufacturer
		Assessment of the efficiency of IA from the perspective of the consumer
		Assessment of the efficiency of IA from the perspective of the investor
2	Integral efficiency of innovation activity	Economic efficiency
		Scientific and technical efficiency
		Resource efficiency
		Social efficiency
		Ecological efficiency
3	Innovative activity	Cost indicators
		Indicators characterizing the dynamics of innovation
		Indicators of renewability
		Structural indicators
4	Innovative capacity	Level of scientific and technical reserve
		Resource capacity
		Financial capacity
		Infrastructure capacity
		Intellectual capacity
		Organizational capacity
		Entrepreneurial capacity
Industrial capacity		

The study of problems of assessing the efficiency of innovation activity of enterprises of the electric power industry showed that they are both general and specific. Among the general problems of assessing the efficiency of innovation activity of enterprises of the electric power industry, the following are distinguished. Firstly, the differentiation in the assessment of the efficiency of innovations of varying degrees of radicality has not been sufficiently elaborated under the stipulation that today imitative and modernizing innovations dominate in the Russian entrepreneurial environment.

Secondly, there are no private assessments related to the engineering innovations, knowledge economy innovations based on fundamental science, and assessments related to the quality of innovation management [2, 3].

Thirdly, at the current stage, the assessment of the efficiency of innovation activities of enterprises often comes down to either the assessment of statistical indicators of innovation activity, or to the assessment of the final results within certain aspects of innovation activity. Taking into account the principles for assessing the innovation activity of economic systems, the current trends in the development of assessment methods, as well as the identified key problems in assessing the innovation activity of enterprises of the electric power industry, an algorithm for their solution was developed. This algorithm is presented in Figure 1.

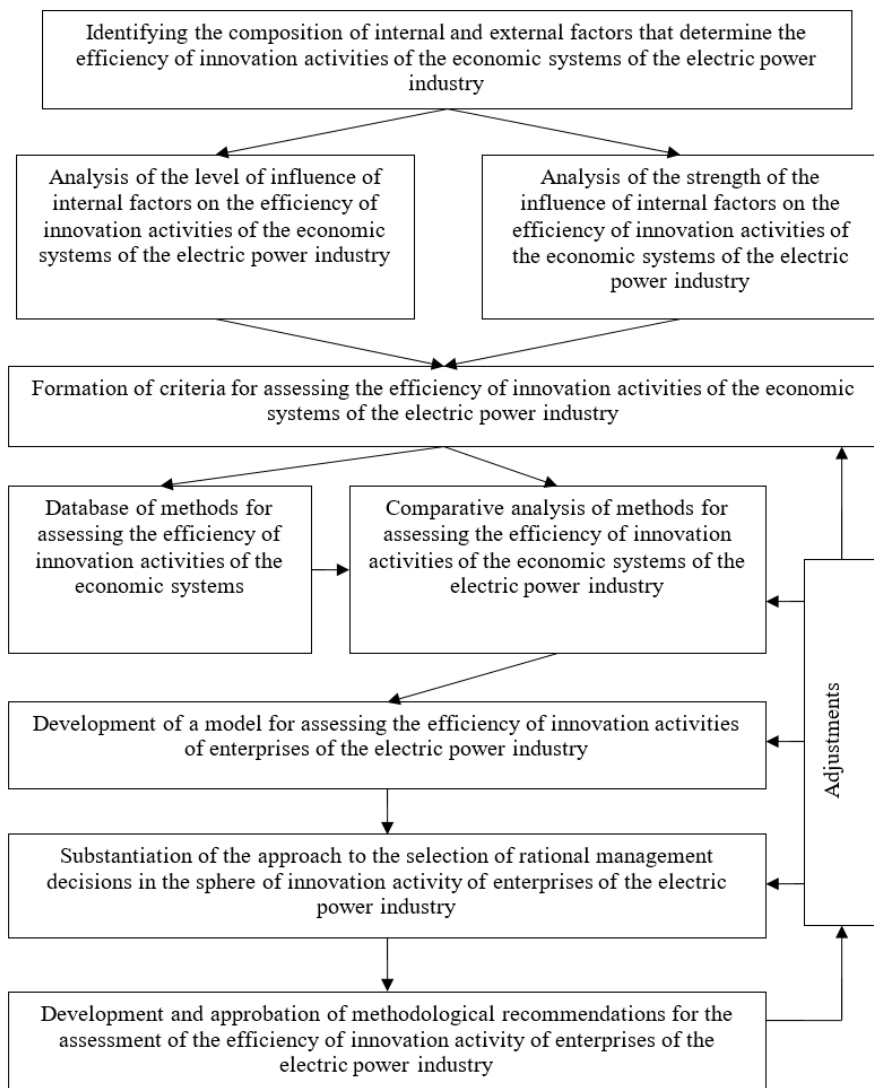


Fig. 1. Algorithm for solving the problem of assessing the innovation activity of the economic systems of the electric power industry.

As a result of the conducted studies, the set of external and internal factors of various degree of manageability determining the efficiency of innovation activity of enterprises of the electric power industry is highlighted (Table 2). The greatest positive influence on the efficiency of innovation activity of enterprises of the electric power industry is provided by the acquisition of new equipment, as well as education and training of personnel [4].

Table 2. Set of external and internal factors affecting the efficiency of innovation activity of enterprises of the electric power industry.

External unmanageable macroeconomic factors			External partially manageable microeconomic factors		
Economy	Politics	Legislation	Local authorities	Investors	Fiscal authorities
Social	Cultural	Justice	Certification	Suppliers	Consumers

environmen t	environment		authorities		
Climatic conditions	Geographical conditions	Environmenta l conditions	Infrastructur e (industrial, transport, information)	Supply chain intermediarie s	Sales intermediarie s
State of the market	Scientific and technical progress	International division of labor and foreign trade relations	Recruitment agencies	Market (competitors)	Consumer unions
Internal partially manageable microeconomic factors			Internal fully manageable microeconomic factors		
Authorized capital	Legal organizational form	Issue of securities	Quality system	Production	Finances
Wage level	Establishmen t of intellectual property rights	Conditions for admission and dismissal of employees	Supply	Management system	Sale
Tax deductions	Labor productivity	Depreciation deductions	Personnel	Innovative developments	Infrastructure
Internal factors of innovation activity					
Research and developmen t	Acquisition of new equipment	Acquisition of new technologies	Acquisition of software	Education and training of personnel	Acquisition of rights to patents and licenses
Marketing research					

Moderate positive influence on the efficiency of innovation activities of enterprises of the electric power industry is provided by the level of marketing research, as well as the acquisition of software. Negative influence on the efficiency of innovation activity of enterprises of the electric power industry is provided by: the level of conduction of their own research and development, the level of acquisition of new technologies and the level of novelty of the acquired rights to patents and licenses.

The conducted analytical studies of the influence of internal and external factors that determine the efficiency of innovation activity of enterprises of the electric power industry have demonstrated the need to develop criteria for assessing the efficiency of innovation activity of enterprises of the electric power industry that take into account not only its results but also the dynamics of the innovation processes that constitute innovation activity [5].

The integral criterion for assessing the efficiency of innovation activity of enterprises of the electric power industry K_{int} was formulated in the process of research in the form of:

$$K_{int} = K_{ic} \cdot K_{ia} \cdot K_{pr} \cdot K_{ria}, \quad (1)$$

where K_{ic} - assessment of innovation capacity, K_{ia} - assessment of innovation activity, K_{pr} - assessment of innovation processes, K_{ria} - assessment of the results of innovation activity.

The group criterion for assessing the results of innovation activity of the electric power enterprise demonstrates the combined strength of the positive effects that arise at the enterprise of the electric power industry with the implementation of innovation activity.

On the basis of the above, we have developed a model for assessing the efficiency of innovation activity of enterprises of the electric power industry (Figure 2). The proposed model makes it possible to assess the efficiency of innovation activity of enterprises of the electric power industry of different functional orientation, which implement innovative changes of various types and varying degrees of radicality. At the same time, the components of innovation activity determine the choice of methods for assessment, while the specifics of the activity of enterprises and the characteristics of innovations determine the weight of the components of group assessments of the efficiency of innovation activity [6].

3 Results

The obtained integral assessment of efficiency of innovation activity of enterprises of the electric power industry can be compared with integral assessment of efficiency of innovation activity of the reference enterprise on the regional, state and world level. Also it can be analyzed by group components.

Table 3. Model for assessing the efficiency of innovation activities of enterprises of the electric power industry.

Type of electric power industry enterprises	Generating enterprises		Transportation enterprises		Sales enterprises		Repair and service enterprises	
↓	Description of innovation activity, including:							
Type of innovation changes	Production		Technological		Organizational		Market	
↓	The level of radicality of innovation							
The level of radicality of innovation	Inventions		Innovations		Modernizations		Imitations	
↓	Implementation of the components of innovation activities							
Implementation of the components of innovation activities	Development of innovative capacity		Manifestation of innovation activity		Implementation of innovation processes		Achievement of results of innovation activity	
Selection of methods for assessing the efficiency of innovation	Method of expert assessments	Method of extrapolation	Method for assessing the level of optimization	Method for assessing the balance of indicators	Method of assessment based on simulation	Method of integrated assessment	Method of integral assessment	
Assessment of the weight of elements for the components of innovation activity	λ_i		α_j		φ_w		μ_s	
Assessment of group components of innovation	K_{ic}		K_{ia}		K_{pr}		K_{ria}	

activities				
Result:	Integral assessment of the efficiency of innovation activity of enterprises of the electric power industry K_{int}			

Taking into account the developed model for assessing the efficiency of innovation activities of enterprises of the electric power industry, the approach to selection of rational management decisions that improve the efficiency of innovation activity of enterprises of the electric power industry was substantiated. The algorithm that realizes the results of the substantiation of this approach is shown in Figure 3 [7].

On the basis of the analysis of innovation activity of enterprise of the electric power industry, the offered algorithm assumes a choice of the reference enterprise, an assessment of level and reserves of increase of efficiency of innovation activity by group criteria defined by the equation:

$$\Delta K_{gr} = K_{gr}^* - K_{gr} > 0, \quad (2)$$

where K_{gr}^* - the assessed limit of the expected efficiency by the group criterion, achievable due to the management decisions implemented without additional investment.

The fact that integral assessment of the efficiency of innovation activity of the enterprise exceeds the reference level ($K_{int} > K_{gr}^{ref}$) indicates the expediency of the transition to the implementation of innovations of a higher level of radicality. If the management reserves are insufficient, then there is an objective need for additional targeted investment in the development of the components of innovation activity.

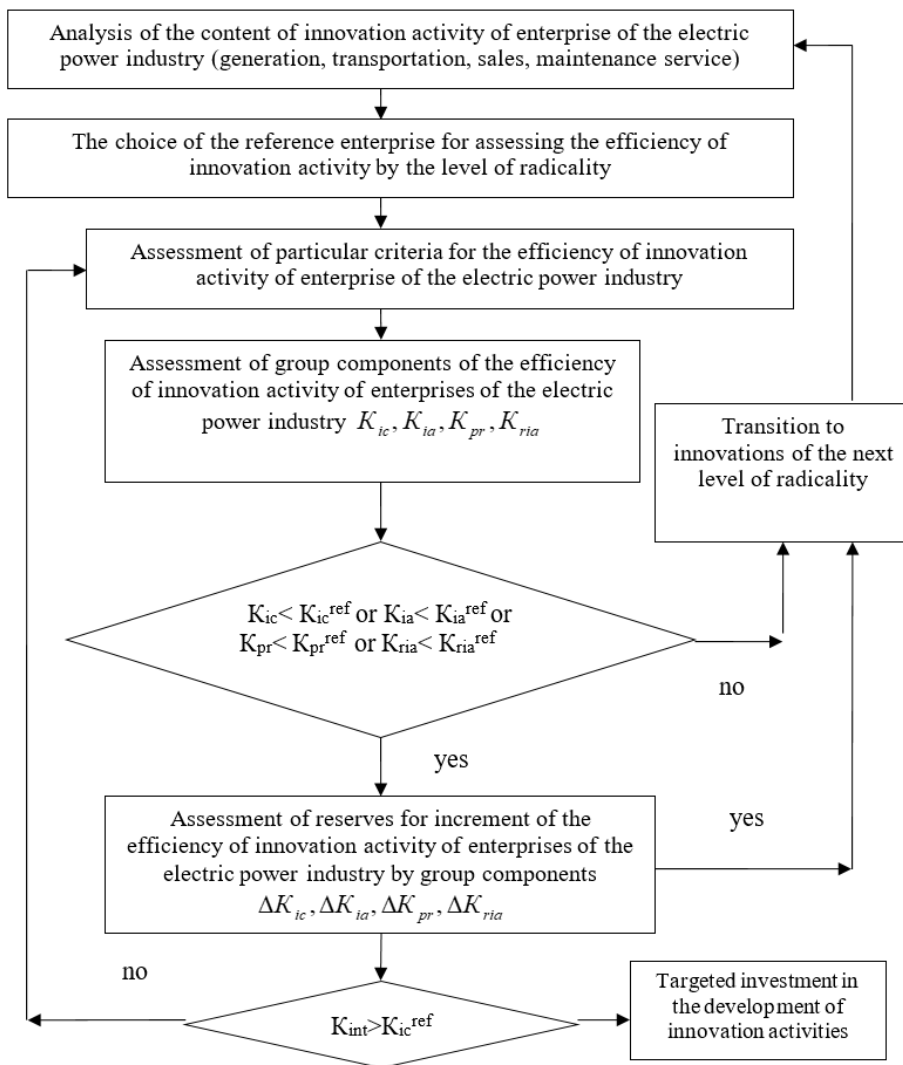


Fig. 2. Algorithm for increasing the efficiency of innovation activity of the electric power enterprise.

4 Conclusion

The identified problems of assessing the efficiency of innovation activity of enterprises of the electric power industry made it possible to develop an effective algorithm containing an analytical block (improving the criteria for assessing the efficiency of innovation activity of enterprises of the electric power industry), a synthetic block (substantiation of the approach to selection of rational management decisions to improve the efficiency of innovation activity of enterprises of the electric power industry) and a scientific and practical block (aimed at developing methodological recommendations to assess the efficiency of innovation activities of enterprises of the electric power industry).

The model for assessing the efficiency of innovation activity is proved. This model allows implementing the assessment of efficiency of the enterprises of various functional

orientations, which conduct innovative changes of various types and various degree of radicality.

References

1. Y. Shin, D.-W. Kim, S.-W. Yang, H.-H. Cho, K.-I. Kang, *ISARC 2008 - Proceedings from the 25th International Symposium on Automation and Robotics in Construction* (2008)
2. Y. Kog, *Practice Periodical on Structural Design and Construction* (2008)
3. V. Kankhva, IOP Conf. Series: Earth and Environmental Science **90**, 012175 (2017) doi:10.1088/1755-1315/90/1/012175
4. S.V. Domnina, E.V. Savoskina, N.V. Shekhova, *Procedia Engineering* **153**, 741-746 (2016)
5. T. Simankina, M. Romanovich, O. Tsvetkov, MATEC Web of Conferences **53**, 01054 (2016)
6. R. Lee, A. Lukin, *Russia's Far East: New Dynamics in Asia Pacific and Beyond* (Boulder, Colorado, 2016)
7. L. Ustinovicus, R. Rasiulis, L. Nazarko, T. Vilutienė, M. Reizgevicus, *Procedia Engineering* **122**,166-171 (2015)