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# ENERGY-ENTROPIC VALUE OF ORGANIZATION'S RESOURCES

The **subject** of the study are approaches and methods for determining the energy and entropy values of the organization's resources. The **purpose** of this study is to develop a concept and appropriate mathematical tools for determining and analyzing the dynamics of the energy-entropic value of the organization's resources. To achieve this goal, it is necessary to perform the following **tasks**: determine the expression of energy entropy, formulate a model of the organization's energy turnover, develop a system of indicators to determine the entropy value of the organization's resources. The following **methods** are used: system analysis, probability theory, energy-entropy theory. **Results**. As a result of the study, it was found that in the process of the organization's activity a cycle of protoenergy and energy occurs: energy – protoenergy (resources) - protoenergy (product) – energy. The relationship between the incoming and outgoing energy of the organization is established, which made it possible to generalize the concept of "efficiency" within the framework of the energy-entropy approach. Unlike classical efficiency, it is proposed that the entropy be considered an alternative measure of the "effective organization of the system". Based on this, the value of the organization's resources is formed from two components – energy and entropy. In the framework of the energy-entropic concept of the organization and the energy turnover under consideration, the energy value of resources is defined as the ratio of the organization's incoming and outgoing energy over a certain period of time. In this interpretation, the energy value of the organization's resources is a kind of analogue of efficiency. It has been established that the value of resources can be considered both integrally and separately for each type of resource. Also, the paper proposes indicators reflecting the entropy value of resources in monetary terms. **Conclusions**. In this study, the category "value of the resources of the organization" is considered in the framework of the energy-entropic concept of the organization. The model of energy circulation of the organization is formulated and the value of the organization is considered from the point of view of energy efficiency and energy entropy. A system of indicators has been developed that makes it possible to comprehensively evaluate the entropy value of each resource individually and their total value. A tool for analyzing the dynamics of energy entropy is also proposed, and a relative indicator of the dynamics of entropies is substantiated, which comprehensively assesses structural and qualitative changes in the organization and makes it possible to identify problems of an energy-organizational nature that need to be addressed.

**Keywords**: entropy; energy turnover; resources; value; organization.

## Introduction

The evolutionary transformation of the conceptual principles of the theory of organizations over the past century has demonstrated the transition from a production-oriented approach to managing organizations to a value-oriented one. "Econophysics" and "energy entropics", which are based on physical methods of analyzing economic data, have spread in modern sciences. As a result, priorities in theory and practice are shifting from full determinism and certainty to the creation of verbal, highly abstract models for describing the activities of organizations. An example of such a methodological approach is the energy-entropic theory of organizations.

## Analysis of literature and research

The first fundamental work, which summarizes all the knowledge about energy entropy that existed at that time, and formulates the basic laws of "energy entropics" as a universal methodology for studying various phenomena and processes using entropy balances, is [1]. In [2], the authors proposed using the measurement of entropy as a project management tool. Also, the work [3] belongs to the number of scientific studies in this direction, where the author draws attention to the problems of managing the organization based on the fundamental laws of dynamics of various macro-systems based on energy conversion. Some types of "energy" of the enterprise are considered in the works [4-7].

Entropy as a measure of one or another variant of the organization's development is considered in [8], where certain guidelines for further theoretical developments in this direction are given in the form of the "energy balance" of organizations. The balance of energies and the dynamics of entropy in an enterprise in the process of its progressive development was identified in [5], by the author the energy means the capital of the enterprise, and commodity-money relations act as "quasi-energy".

In [6], two scenarios of free energy and the entropy of a system (organization) in the context of its stability are analyzed. The author considers the decrease in entropy in the system as the result of an adequate reaction to changes in the environment, but the regularity proposed by him is conceptual in nature and requires further research. An attempt to empirically study the organization's entropy is presented in [9], the authors focus on the relationship between entropy and business processes in the organization and the need for further study. In a study [10], the author defines economic value as a mathematical decrease in entropy and explores the relationship between physical entropy and economic value.

The purpose of this study is developing a concept and appropriate mathematical tools for determining and analyzing the dynamics of the energy-entropic value of the organization's resources.

This work is a continuation of the ideas of the energy-entropic concept of organization [11] and the concept of the value of resources presented in [12-16].

## Research results

Let's describe the conceptual model of energy circulation and energy entropy of the organization. So, the basic concepts of energy-entropy theory are "energy" and "work". Energy is what is transformed into work. For

6

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organizations, work is done through resources. Thus, resources act as an analogue of energy. This approach is used in all modern works in this direction. In some publications (for example, [5,6]), the authors use the term "*quasienergy*", in the context of the fact that resources are not "energy" in its true sense, but (according to the meaning of "quasi") *fake energy, almost energy, pseudo-energy*. This approach is, of course, correct, taking into account the *essence of energy as what is converted into work* [3].

Obviously, if an organization uses human resources (for example, 20 employees) in the production process, this does not mean that these resources are directly converted into work. This means that the knowledge, skills, experience and competencies of this personnel are transformed into work. Therefore, a human resource is a "*protoresource*" (proto-from protos first, primary). But for the organization, the monetary equivalent of using the knowledge, skills, experience and competence of this personnel represents the expended "energy" (or "quasi-

energy" if you hold the opinion [5]). Thus, from an organization's point of view, energy is money.

In the simplest version of considering the essence of "work" for an organization as fulfilling its main function (for example, producing a certain product), the result of the work is a "product" for which the organization receives cash proceeds. Following the above reasoning, the organization's product is also proto-energy, and cash receipts for the sold product form energy.

Given the fact that the *energy-entropic theory of organization* is formed on the basis of the universal laws of energy-entropics, in the framework of which "energy" is considered as a broad concept, we will use the terms "energy" and "proto-energy" in the future. Thus, the protoenergy of both resources and the product "generates" energy.

So, the following cycle of *protoenergy and energy* arises: energy – protoenergy (resources) – protoenergy (product) – energy (fig. 1).
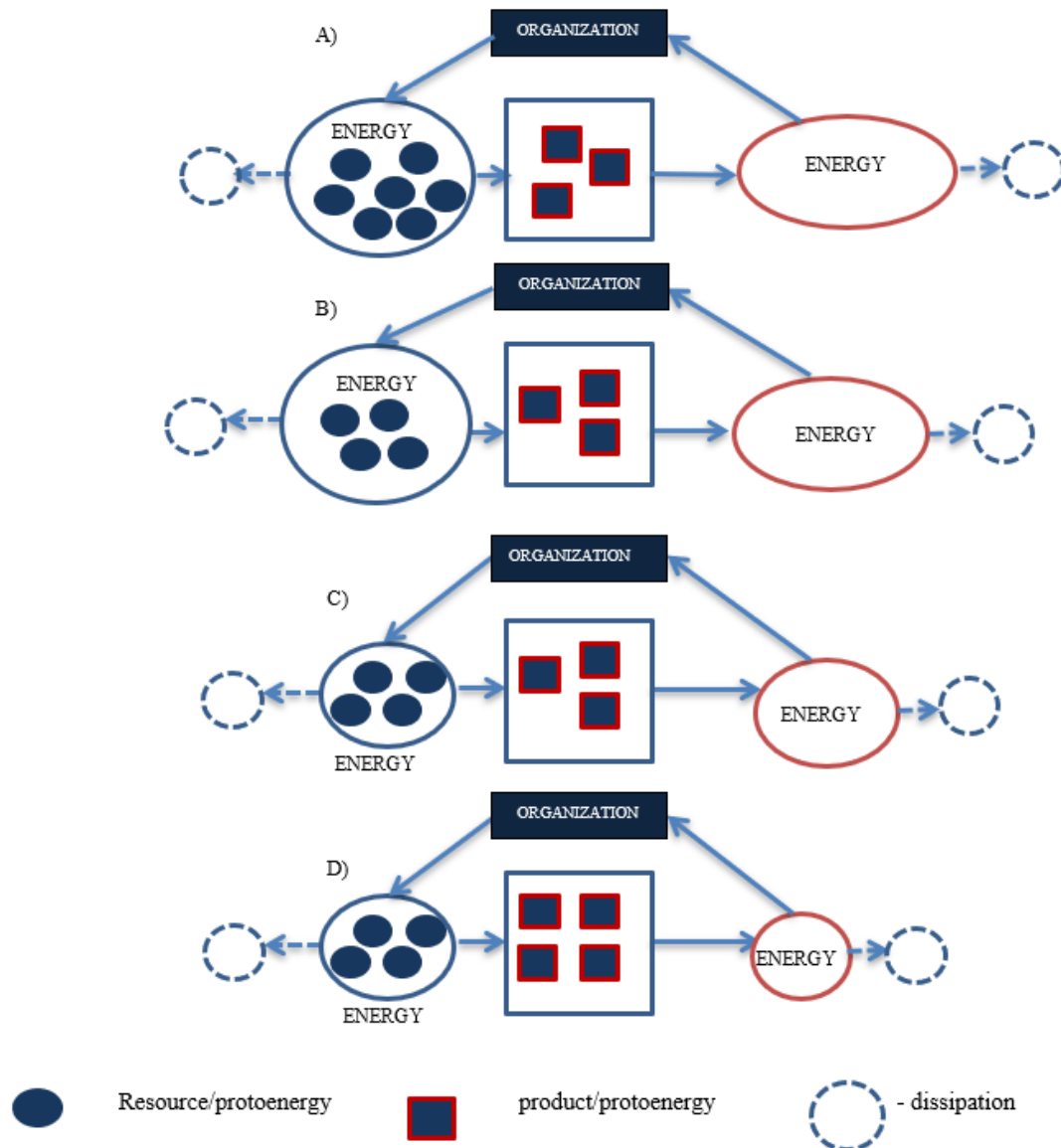


**Fig. 1.** Organization's energy turnover

Note that fig.1 shows examples of various options for the energy turnover of organizations, while the emphasis is on energy circulation as the integration of *incoming and outgoing energy flows* in the process and according to the results of work. Energy dissipation is noted schematically, but its comparative assessment is not presented in this figure.

We note that energy dissipation [11] occurs both for outgoing and incoming energy. The main causes of dissipation are:

- natural energy losses, for example, associated with the aging of the material and technical base ([5, 11]) or due to force majeure circumstances (for example, natural disasters, etc.).

- energy losses due to inefficiency of business processes.

Briefly describe the options presented in fig. 1 A) and B) variants use a different amount of proto-energy of the resources, but the same amount of energy to produce the same amount of proto-energy of the product and produce the same amount of energy. Thus, for organizations A) and B), the same energy flows are provided by a different amount of resources.

Organizations B) and C) have the same composition of resources, but the energy spent on them is lower for organization C), while with the same amount of product, the energy received is higher for organization B). Organizations B) and D) with the same energy spent on resources, receive a different amount of both products and energy from them.

A natural and logical continuation of these considerations is the establishment of a certain relationship between the incoming and outgoing energy of the organization, which allows us to generalize the concept of "efficiency" in the framework of the energy-entropy approach. But, unlike classical efficiency, the measure of "effective organization of the system" is entropy. *Therefore, the value of the organization's resources is formed by their two components - energy (a kind of analogue of economic efficiency) and entropy (comprehensively characterizing the value of resources).*

So, the differentiation of the success of organizations in terms of energy turnover arises, first of all, due to the presence of energy entropy, inextricably linked with the informational (structural) entropy of the organization. A different combination of resources and their qualitative saturation determines the level of dissipation $Q$, which can be defined as the "*value of the organization structure*". That is why, with equal opportunities, some organizations are more successful, and, conversely, with less energy opportunities, other organizations are more successful than those with an initially higher energy level.

Since energy entropy is determined by the structure of the organization and the possibility of information control over it, and that part of the external environment that ensures the flow of energy into the organization, we will consider the value of energy entropy:

$$S = \frac{Q}{T} = \frac{U - (E^{in} - E^{ex})}{T}, \qquad (1)$$

where $U$ – total energy organization, $E^{in}$ – incoming energy, $E^{ex}$ – outgoing (free) energy, $T$ – temperature. By the temperature of the organization we understand the ratio of its effectiveness to existing capabilities (fig. 2), that is, as the temperature we take the value:
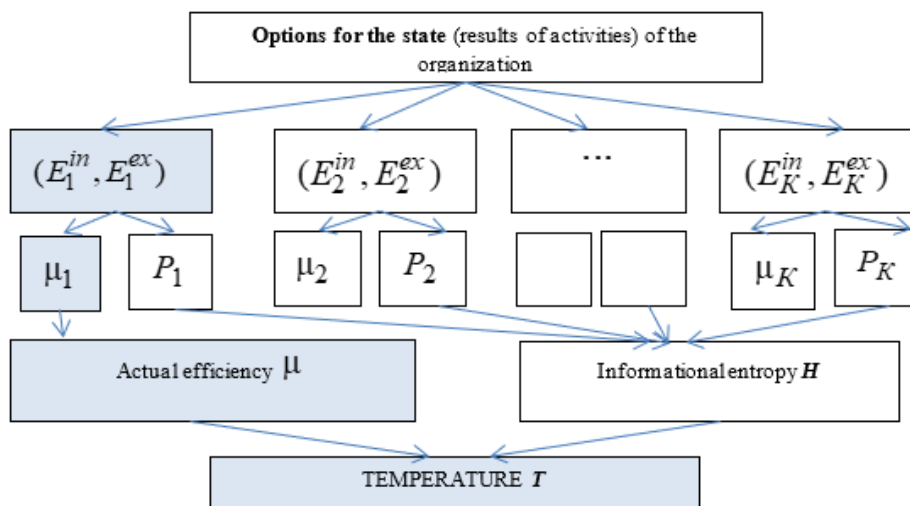
$$T = \frac{\mu}{H}. \qquad (2)$$



**Fig. 2.** Organization temperature formation diagram

$H$ reflects the level of informational entropy of the organization, evaluating in this case the possible options for the state of the organization:

$$H = -\sum_{k=1}^{K} p(A_k) \cdot \ln(p(A_k)), \qquad (3)$$

8

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$A_k$ – organization status options, $p(A_k)$ – the probabilities of these conditions. As indicators of the state of the organization we take $A_k = (E_k^{in}, E_k^{ex}), k = \overline{1, K}$, since it is precisely these indicators at a given level $U$ for the organization that reflect the results of its activities and the efficiency of energy circulation. With an increase of $K$ (i.e., the number of predicted options for the state of the organization) and equalization of their probabilities, information entropy (3) grows. And, on the contrary, with a decrease $K$ and an explicit allocation of sufficiently predictable (that is, with a high probability of options) (3) it will decrease. Thus, in (2), informational entropy reflects a measure of order in an organization:

$$\mu = \frac{\eta}{\eta *} = \frac{U - E^{ex} + E^{in}}{\eta * \cdot U}, \tag{4}$$

$$\eta = \frac{U - E^{ex} + E^{in}}{U}, \tag{5}$$

where $\eta *$ – benchmark performance indicator, $\eta$ – performance indicator, which reflects the "return" from the total energy of the organization in the form of an increase in energy $E^{in} - E^{ex}$.

Thus, the temperature reflects the state of the organization, which was realized from the many possible.

In view of (3), (4), the expression for entropy takes the form:

$$S = \frac{U - (E^{in} - E^{ex})}{T} = \frac{(U - (E^{in} - E^{ex}) \cdot U \cdot \eta * \cdot H}{U - E^{ex} + E^{in}} =$$

$$= \frac{((E^{in} - E^{ex}) - U) \cdot U \cdot \eta * \cdot \sum_{k=1}^{K} p(A_k) \cdot \ln(p(A_k))}{U - E^{ex} + E^{in}}. \tag{6}$$

### The energy value of the organization's resources

The above examples illustrate the concept of "*energy value of resources*" (which was introduced in [12,13]). So, organization A) has less valuable resources than organization B), since it provides the same outflows and influxes of energy with more resources. Organization D) has less valuable resources than C), despite the fact that the number of products is greater than D).

Thus, within the framework of the energy-entropic concept of the organization and the energy turnover under consideration, the following definition of the energy value of resources can be given: *the energy value of resources is the ratio of the organization's incoming and outgoing energy for a certain period of time*.

In this interpretation, the energy value of the organization's resources is a kind of *analogue of efficiency*. The value of resources can be considered both integrally (both in the comments on the examples in Fig. 1) and for each type of resource. The decisive role in the formation of a certain level of energy value of the organization's resources belongs to human resources, because it is the "person" who *organizes, coordinates and*

*executes business processes, and energy dissipation and entropy, as well as the ability of protoenergy (resources, product) to generate, depend on them. a certain level of energy.*

So, given the differentiation of resources, the organization can be allocated *various types of resources*.

Since each type of resources (protoenergy) can be detailed (for example, human resources are distributed by type – managerial, labor (directly involved in the production process), etc.), we can distinguish n types of *protoenergy of the organization's resources* and, accordingly, their number by type:

$$E^p = (E_1^p, E_2^p, ...., E_n^p). \tag{7}$$

Thus, components (7) $E_i^p, i = \overline{1, n}$ are quantitative rather than cost characteristics of resources.

The energy that the organization spends on the use of protoenergy (resources) and the receipt of the product (protoenergy):

$$E^{ex} = \sum_{i=1}^{n} k_i \cdot E_i^p, \tag{8}$$

where $k_i, i = \overline{1, n}$ – coefficients of bringing various types of protoenergy to a single estimated indicator - in this case, to monetary units, $E^{ex}$ – the outgoing energy of the organization. After the release of the product (protoenergy) in quantity $W^p$, the organization receives an incoming flow of energy $E^{in}$, which is a certain function of the product:

$$E^{in} = E^{in}(W^p), \tag{9}$$

and in the simplest version - linear:

$$E^{in} = l \cdot W^p, \tag{4}$$

where $l$ – the cost per unit of product that the organization receives.

Note that $E^{ex}$ represents the amount of energy in which dissipation is not taken into account, since this is what is actually "directed" to the completion of the work (i.e., obtaining the product). In turn, $E^{in}$ is the incoming energy, taking into account dissipation.

Then the integral energy value of the organization's resources can be represented as:

$$\varsigma = \frac{E^{in}}{E^{ex}} = \frac{l \cdot W^p}{\sum_{i=1}^{n} k_i \cdot E_i^p}. \tag{10}$$

As already noted, value in a similar way can be determined for each type of resource. In this way:

$$\varsigma_i = \frac{E^{in}}{k_i \cdot E_i^p} = \frac{l \cdot W^p}{k_i \cdot E_i^p}, (i = \overline{1, n}). \tag{11}$$

9

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This value characterizes the value of each type of resource.

Note that the numerator (6) contains the total input energy, and not some part of it, since it is the integral result that allows us to estimate the value of resources.

(10) and (11) imply obtaining dimensionless quantities $\varsigma, \varsigma_i (i = \overline{1,n})$, however, relative values that characterize the "return" per unit of each type of resource will be informationally useful:

$$\varsigma'_i = \frac{E^{in}}{E_i^p} = \frac{l \cdot W^p}{E_i^p}, (i = \overline{1,n}). \quad (12)$$

Considering these indicators in dynamics, that is, for successive periods of time $t_j, j = \overline{1,m}$, it becomes possible to draw a conclusion about the role of each type of resource in obtaining incoming energy $E^{in}$:

$$\varsigma(t_j) = \frac{E^{in}(t_j)}{E^{ex}(t_j)} = \frac{l(t_j) \cdot W^p(t_j)}{\sum_{i=1}^{n} k_i(t_j) \cdot E_i^p(t_j)}, j = \overline{1,m}; \quad (13)$$

$$\varsigma_i(t_j) = \frac{E^{in}(t_j)}{k_i(t_j) \cdot E_i^p(t_j)} = \frac{l(t_j) \cdot W^p(t_j)}{k_i(t_j) \cdot E_i^p(t_j)}, (i = \overline{1,n}, j = \overline{1,m}), (14)$$

$$\varsigma'_i(t_j) = \frac{E^{in}(t_j)}{E_i^p(t_j)} = \frac{l(t_j) \cdot W^p(t_j)}{E_i^p(t_j)}, (i = \overline{1,n}, j = \overline{1,m}), (15)$$

where, $\varsigma(t_j)$, $\varsigma_i(t_j)$, $\varsigma'_i(t_j)$, $W^p(t_j)$, $E_i^p(t_j)$, $l(t_j)$, $k_i(t_j)$ have the same meaning as before, but these values are assigned to a specific time period $t_j, j = \overline{1,m}$.

### Entropic value of organization resources and analysis of its dynamics

As you know, the energy entropy of open systems can only decrease due to the outflow of part of the entropy into the external environment, or, in other words, due to the influx of neganthropy [1]. In [5,9], it was substantiated that energy entropy consists of two parts:

$$S = S_{in} + S_{ex}, \quad (16)$$

where $S_{in}, S_{ex}$ – accordingly, two types of entropy associated with the internal and external environment of the organization. However, the $S_{ex}$ component reflects not just the entropy associated with the external environment, but the entropy associated with the "controlled" part of the external environment. As the "controlled" part of the organization's external environment, we take a structure related to marketing, logistics, information channels, which is not directly included in the organization's structure, but the organization spends its energy (part $S_{ex}$) on this. Thus, $S_{ex}$ is connected, with a kind of "external structure" of the organization.

Nevertheless, despite the separation of the two parts of the organization's energy entropy, both of them are a consequence of the "internal structure" of the organization and, above all, its labor resources, which ensure the organization / ordering of all business processes. That is why, in the expression for energy entropy (6), informational entropy is used, which reflects the options for the complex outcome of the organization's activities.

By analogy with the previous reasoning, the entropy value of an organization's resources will mean their ability to generate and reduce energy entropy. Such a twofold attitude towards energy entropy is due to the fact that in the classics of thermodynamics (where energy entropy comes from), it is precisely its change that reflects the state of the system. Given the specifics of organizations, it is also important for them what level of entropy is achieved, how its dynamics proceed, and due to what.

Therefore, we introduce indicators that reflect the entropy value of resources in monetary terms, that is, the entropy per unit monetary equivalent of outgoing energy as a whole, and for a particular type of resource, in particular:

$$\xi = \frac{S}{E^{ex}} = \frac{S}{\sum_{i=1}^{n} k_i \cdot E_i^p}, \quad (17)$$

$$\xi_i = \frac{S}{k_i \cdot E_i^p}, (i = \overline{1,n}). \quad (18)$$

We also introduce indicators reflecting the entropy value of a unit of resources in their natural expression:

$$\xi'_i = \frac{S}{E_i^p}, (i = \overline{1,n}). \quad (19)$$

By analogy with the previous reasoning, we introduce the dynamics of entropy value in dynamics:

$$\xi(t_j) = \frac{S(t_j)}{E^{ex}(t_j)} = \frac{S(t_j)}{\sum_{i=1}^{n} k_i(t_j) \cdot E_i^p(t_j)}, j = \overline{1,m}; \quad (20)$$

$$\xi_i(t_j) = \frac{S(t_j)}{k_i(t_j) \cdot E_i^p(t_j)}, (i = \overline{1,n}, j = \overline{1,m}), \quad (21)$$

$$\xi'_i(t_j) = \frac{S(t_j)}{E_i^p(t_j)}, (i = \overline{1,n}, j = \overline{1,m}), \quad (22)$$

where, $\xi(t_j)$, $\xi_i(t_j)$, $\xi'_i(t_j)$, $E_i^p(t_j)$, $k_i(t_j)$ have the same meaning as before, but these values are assigned to a specific time period $t_j, j = \overline{1,m}$.

Then the absolute increase in the entropy value of different categories will take the form:

$$\Delta\xi(t_j) = \xi(t_j) - \xi(t_{j-1}), (j = \overline{2,m}), \quad (23)$$

10

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$$\Delta\xi_i(t_j) = \xi_i(t_j) - \xi_i(t_{j-1}), (i = \overline{1,n}, j = \overline{2,m}), \quad (24)$$

$$\Delta\xi'_i(t_j) = \xi'_i(t_j) - \xi'_i(t_{j-1}), (i = \overline{1,n}, j = \overline{2,m}). \quad (25)$$

A peculiar result of the analysis of the entropy value of resources is its relative change. Since the dynamics change not only the entropy of the organization, but also its resources, the relative indicators of the dynamics of the entropy value of the organization will also be useful for analysis. To do this, we introduce the quantities:

$$\Delta S(t_j) = S(t_j) - S(t_{j-1}), (j = \overline{2,m}), \quad (26)$$

*increase in entropy over a period of time* $\left[t_{j-1}, t_j\right], j = \overline{2,m};$

$$\Delta E^{ex}(t_j) = E^{ex}(t_j) - E^{ex}(t_{j-1}), (t = \overline{2,m}), \quad (27)$$

*increase in outgoing energy over a period of time* $\left[t_{j-1}, t_j\right], j = \overline{2,m};$

$$\Delta E_i^p(t_j) = E_i^p(t_j) - E_i^p(t_{j-1}), (i = \overline{1,n}, j = \overline{2,m}), \quad (28)$$

*growth of the i-th resource over a period of time* $\left[t_{j-1}, t_j\right], j = \overline{2,m},$

$$\Delta k_i(t_j) = k_i(t_j) - k_i(t_{j-1}), (i = \overline{1,n}, j = \overline{2,m}), \quad (29)$$

*increase in the cost of the i-th resource* over a period of time $\left[t_{j-1}, t_j\right], j = \overline{2,m}.$

Relative indicators of the dynamics of the entropy value of resources are expressed as follows:

$$\upsilon(t_j) = \frac{\Delta S(t_j)}{\Delta E^{ex}}, (j = \overline{1,m}), \quad (30)$$

$$\upsilon_i(t_j) = \frac{\Delta S(t_j)}{\Delta k_i(t_j) \cdot \Delta E_i^p(t_j)}, (i = \overline{1,n}, j = \overline{2,m}), \quad (31)$$

$$\upsilon'_i(t_j) = \frac{\Delta S(t_j)}{\Delta E_i^p(t_j)}, (i = \overline{1,n}, j = \overline{2,m}). \quad (32)$$

A change in the organization's energy entropy occurs, among other things, as a result of a change in its temperature, which, in turn, depends on informational entropy and the organization's effectiveness. Since the analysis of efficiency was presented above and within the framework of the energy-entropic theory is not a central issue for its further detailing, we will dwell in more detail on the change in the energy-entropy of an organization under the influence of changes in its information entropy.

We offer the following relative indicator of *the dynamics of the entropy of the organization*:

$$\varepsilon(t_j) = \frac{\Delta S(t_j)}{\Delta H(t_j)}, (j = \overline{2,m}), \quad (33)$$

where,

$$\Delta H(t_j) = H(t_j) - H(t_{j-1}), (j = \overline{2,m}) \quad (34)$$

- increase in information entropy over a period of time $\left[t_{j-1}, t_j\right], j = \overline{2,m}.$

Expression (33) also characterizes indirectly the value of the organization's human resources, since, first of all, the organization order depends on them (their competencies and energy [13]). Note that, despite the fact that energy entropy $S(t_j)$ depends on $H(t_j)$, nevertheless, the ratio of their changes is quite useful for analyzing the dynamics of the organization's performance, identifying problems and finding the necessary solutions to eliminate them.

We also note that a positive change in information entropy along with a decrease in energy entropy is the main evidence of the high level of human resources of the organization, demonstrating their ability to "cope" with the entropy of both types.

## Conclusions

In this study, the category "value of the resources of the organization" is considered in the framework of the energy-entropic concept of the organization. The expression of the organization's energy entropy is presented, which is based on taking into account the organization's activity efficiency and its informational entropy as a measure of order.

A model of the organization's energy turnover is formulated and the value of the organization is considered from the perspective of two points of view - energy efficiency (by analogy with economic efficiency) and energy entropy.

A system of indicators has been developed that makes it possible to comprehensively evaluate the entropy value of each resource individually and their total value. A tool for analyzing the dynamics of energy entropy is also proposed and a relative indicator of the dynamics of entropies is introduced, which comprehensively assesses structural and qualitative changes in the organization and allows you to identify problems of an energy-organizational nature that need to be addressed.

**References**

1. Alekseev, G. N. (1983), *Energyentropics* [*Energoentropika*], Moscow, Knowledge, 268 p.
2. Bushuyev, S., Sochnev, S. (1999), "Entropy measurement as a project control tool", *International Journal of Project Management*, No. 17 (6), P. 343–350.
3. Petrenko, A. V. "Organization management as a struggle with entropy" ["Upravleniye organizatsiyey kak bor'ba s entropiyey"], *Institutional repository of the National Aviation University of Ukraine*, available at: www.er.nau.edu.ua/bitstream/NAU/14626/1/Entropy

4. Yagelskaya, E. Yu. (2013), "The essence and structure of economic energy" ["Sushchnost' i struktura ekonomicheskoy energii"], *Problems of Economics and Management*, No. 8 (24), P. 98–111.

5. Likhonosova, G. S. (2018), "Entropy balancing: a tool for eliminating socio-economic exclusion at the enterprise" ["Entropy balance: the instrument for the consolidation of social and economic vodtorgneny"], *Chronicle of economic reforms*, No. 2, P. 43–51.

6. Melnik, L. G. (2013), "Analysis of the energy-entropic prerequisites for the progressive development of economic systems" ["Analiz energoentropiynykh predposylok progressivnogo razvitiya ekonomicheskikh system"], *Actual problems of economics*, No. 10, P. 15–22.

7. Bushuyev, S. D., Yaroshenko F., Yaroshenko N. (2013), "Entrepreneurial energy in the management of development projects" ["Predprinimatel'skaya energiya v upravlenii proyektami razvitiya"], *Project management and production development*, No. 2, P. 5–12.

8. Shakhov, A. V. (2014), "Entropy model of portfolio management of a project-oriented organization" ["Entropiynaya model' portfel'nogo upravleniya proyektno-oriyentirovannoy organizatsiyey"], *Project Management and Development of Network*, No. 2, P. 87–95.

9. Ceptureanu, E. G., Ceptureanu, S. I., Popescu, D. I. (2017), "Relationship between Entropy, Corporate Entrepreneurship and Organizational Capabilities in Romanian Medium Sized Enterprises", *Entropy*, No. 19, P. 412. DOI: https://doi.org/10.3390/e19080412

10. Chen, Jing (2002), "An Entropy Theory of Value", *SSRN Electronic Journal*, available at: https://www.researchgate.net/publication/228398386_An_Entropy_Theory_of_Value

11. Bondar, A., Bushuyev, S., Onyshchenko, S., Hiroshi, H. (2020), "Entropy Paradigm of Project-Oriented Organizations Management", *Proceedings of the 1st International Workshop IT Project Management (ITPM 2020) Volume 1. Lviv, Ukraine, February 18-20, 2020, CEUR Workshop Proceedings (CEUR-WS.org),* P. 233–243, available at: http://ceur-ws.org/Vol-2565/paper20.pdf

12. Bondar, A. V. (2019), "The concept of the human resources value of a project-oriented organization", *Proceedings of Admiral Makarov NUS*, Helvetik Publishing House, No. 1, P. 135–141. DOI: https://doi.org/10.15589/znp2019.1(475).19

13. Bondar, A. (2020), "Management of human resources of the project-oriented organization based on the profile of the specialist and the degree of its uniqueness", Innovative Technologies and Scientific Solutions for Industries, No. 1 (11), P. 28–34. DOI: https://doi.org/10.30837/2522-9818.2020.11.028.

14. Bondar, A. V., Onishchenko, S. P. (2019), "Optimization of project time parameters", *Managing the development of folding systems*, No. 39, P. 11–18. DOI: https://doi.org/10.6084/M9.FIGSHARE.11340629.V1

15. Onyshchenko, S., Bondar, A., Andrievska, V., Sudnyk, N., Lohinov, O. (2019), "Constructing and exploring the model to form the road map of enterprise development", *Eastern-European Journal of Enterprise Technologies*, Vol. 5, No. 3 (101), P. 33–42. DOI: https://doi.org/10.15587/1729-4061.2019.179185

16. Onyshchenko, S., Leontieva A. (2018), "Modeling of the optimal composition of the enterprise technical development program", *Technology audit and production reserves*, No. 5 (2), P. 36-41. DOI: https://doi.org/10.15587/2312-8372.2018.146463

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# ЕНЕРГОЕНТРОПІЙНА ЦІННІСТЬ РЕСУРСІВ ОРГАНІЗАЦІЇ

**Предметом** дослідження є підходи і методи визначення енергетичної та ентропійної цінності ресурсів організації. **Метою** даного дослідження є розробка концепції та відповідного математичного інструментарію визначення та аналізу динаміки енергоентропійної цінності ресурсів організації. Для досягнення поставленої мети необхідно виконати наступні **завдання**: визначити вираз енергоентропії, сформулювати модель енергообігу організації, розробити систему показників, що дозволяють визначати ентропійну цінність ресурсів організації. Використовуються такі методи: системний аналіз, теорія ймовірності, енергоентропійна теорія. **Результати**. В результаті дослідження встановлено, що в процесі діяльності організації виникає колообіг протоенергії і енергії: енергія - протоенергія (ресурси) - протоенергія (продукт) - енергія. Встановлено співвідношення між вхідною та вихідною енергією організації, що дозволило узагальнити поняття "ефективність" в рамках енергоентропійного підходу. На відміну від класичної ефективності, запропоновано альтернативною мірою "ефективної організації системи" вважати ентропію. Виходячи з цього, цінність ресурсів організації формується з двох складових - енергетичної та ентропійної. В рамках енергоентропійної концепції організації і розглянутого енергообігу, енергетична цінність ресурсів визначена як співвідношення вхідної та вихідної енергії організації за певний проміжок часу. У такій інтерпретації енергетична цінність ресурсів організації є своєрідним аналогом ефективності. Встановлено, що цінність ресурсів може розглядатися як інтегрально, так і для кожного виду ресурсу окремо. Також в роботі запропоновані показники, що відображають ентропійну цінність ресурсів в грошовому еквіваленті. **Висновки**. В даному дослідженні категорія «цінність ресурсів організації» розглянута в рамках енергоентропійної концепції організації. Сформульовано модель енергообігу організації і розглянута цінність організації з позиції енергоефективності та енергоентропії. Розроблено систему показників, що дозволяє в комплексі оцінювати ентропійну цінність кожного ресурсу окремо і їх сумарну цінність. Також запропонований інструмент аналізу динаміки енергоентропії і обгрунтований відносний

показник динаміки ентропій, який комплексно оцінює структурні і якісні зміни в організації і дозволяє виділити проблеми енергетично-організаційного характеру, які потребують вирішення.

**Ключові слова**: ентропія; енергообіг; ресурси; цінність; організація.

# ЭНЕРГОЭНТРОПИЙНАЯ ЦЕННОСТЬ РЕСУРСОВ ОРГАНИЗАЦИИ

**Предметом** исследования являются подходы и методы определения энергетической и энтропийной ценности ресурсов организации. **Целью** данного исследования является разработка концепции и соответствующего математического инструментария определения и анализа динамики энергоэнтропийной ценности ресурсов организации. Для достижения поставленной цели необходимо выполнить следующие **задачи**: определить выражение энергоэнтропии, сформулировать модель энергооборота организации, разработать систему показателей, позволяющих определять энтропийную ценность ресурсов организации. Используются следующие методы: системный анализ, теория вероятности, энергоэнтропийная теория. **Результаты**. В результате исследования установлено, что в процессе деятельности организации возникает круговорот протоэнергии и энергии: энергия - протоэнергия (ресурсы)– протоэнергия (продукт) – энергия. Установлено соотношение между входящей и исходящей энергией организации, что позволило обобщить понятие "эффективность" в рамках энергоэнтропийного подхода. В отличие от классической эффективности, предложено альтернативной мерой "эффективной организации системы" считать энтропию. Исходя из этого, ценность ресурсов организации формируется из двух составляющих – энергетической и энтропийной. В рамках энергоэнтропийной концепции организации и рассматриваемого энергооборота, энергетическая ценность ресурсов определена как соотношение входящей и исходящей энергии организации за определенный промежуток времени. В такой интерпретации энергетическая ценность ресурсов организации является своеобразным аналогом эффективности. Установлено, что ценность ресурсов может рассматриваться как интегрально, так и для каждого вида ресурса отдельно. Также в работе предложены показатели, отражающие энтропийную ценность ресурсов в денежном эквиваленте. **Выводы**. В данном исследовании категория «ценность ресурсов организации» рассмотрена в рамках энергоэнтропийной концепции организации. Сформулирована модель энергооборота организации и рассмотрена ценность организации с позиции энергоэффективности и энергоэнтропии. Разработана система показателей, позволяющая в комплексе оценивать энтропийную ценность каждого ресурса в отдельности и их суммарную ценность. Также предложен инструмент анализа динамики энергоэнтропии и обоснован относительный показатель динамики энтропий, который комплексно оценивает структурные и качественные изменения в организации и позволяет выделить проблемы энергетическо-организационного характера, требующие решения.

**Ключевые слова**: энтропия; энергооборот; ресурсы; ценность; организация.

*Бібліографічні описи / Bibliographic descriptions*

Бондар А. В. Енергоентропійна цінність ресурсів організації. *Сучасний стан наукових досліджень та технологій в промисловості*. 2020. № 2 (12). С. 5–12. DOI: https://doi.org/10.30837/2522-9818.2020.12.005.

Bondar, A. (2020), "Energy-entropic value of organization's resources", *Innovative Technologies and Scientific Solutions for Industries*, No. 2 (12), P. 5–12. DOI: https://doi.org/10.30837/2522-9818.2020.12.005.