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THE IMPACT OF INFORMATION TECHNOLOGIES IN INCREASING THE EFFICIENCY OF THE OPERATIONAL MANAGEMENT OF ELECTRICAL NETWORKS (CASE STUDY BASED ON "RED-NORD" JS COMPANY)

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Abstract

The present paper represents a methodological foray into the elucidation of the human factor contribution in the efficiency of the operative management of electrical networks. The study is pursuing the role of information technologies in the efficiency of the management of electrical networks on the example of the "Red-Nord" JS company. In order to achieve the general objective of the research, we have analyzed the main information technologies that can be applied in the operative management of the energy enterprise. At the same time, the ANRE (the National Agency for Energy Regulation of the Republic of Moldova) regulations regarding the efficiency of the operative management of electrical networks were reviewed, with the elucidation of the role of dispatchers in the operative management of electrical networks. As a result, the main activity indicators of the "Red-Nord" JS company were analyzed, along with the operational management indicators of the electricity networks in the period of 2019-2021. At the same time, conclusions and recommendations were drawn regarding the efficiency of the operative management of electrical networks through the lens of the human factor development and the introduction of information technologies.

The research methods used to elaborate this study are: analysis and synthesis, induction, deduction, empirical research, comparative analysis, which helped us to identify the contribution of the human factor in the operative management of electrical networks.

In conclusion, we can note that in the last 5 years, "Red-Nord" JS company has implemented modern software in order to make the operational management of electric networks more efficient, such as: the information system of planned records, the implementation of the SCADA system, the reorganization of the dispatching system. However, we consider it necessary to make the following optimizations: making the call reception system more efficient, in order to introduce new functions that would allow reducing the response time from of company to the final consumers. Consequently, the improvement of the SCADA/OMS software would allow the efficiency of the company's activity and increase the organizational performance.

Keywords*: information technologies, energy management, operational management of electrical networks, electricity*

1. Introduction

An important impulse in the implementation of information technologies in energy management is constituted by various energy crises, which aggravate the problems and contradictions occurred in the various stages of the economic cycle: in the field of production, distribution, or consumption of energy resources.

One of the most significant factors that led to the transition to the modern stage of development of energy efficiency approaches, was the energy crisis of the 1970s, which caused an increase in energy prices and, indubitably, contributed to the increase in the inflation rate. The resulting macroeconomic effect was a profound energy crisis, which generated a slowdown in the growth of economic activity in developed countries and the mass deployment of energy-saving technologies. The latter represents one of the most important tools for increasing the competitiveness of energy companies.

We are currently feeling the effects of the profound energy crisis that has gripped the whole of Europe. The crisis is transposed by the call of energy companies to implement a SMART energy management system, focused on saving energy resources, as well as on optimizing processes, on the introduction of modern technologies in order to make all processes in the energy sector more efficient, which will ultimately contribute to reducing costs for the energy companies and increasing their competitiveness.

2. The current level of investigation of the issue

The 21st century marks the age of knowledge explosion, an age marked by an intense informational abundance. In this era, the management of companies underwent major changes, in order to adapt the managerial processes to the new changes imposed by the business environment. Thus, the “human bone skeleton” gives way to the “digital bone skeleton” transposed by the need to digitize business, to introduce new digital technologies aimed at helping companies cope with globalization processes, where the continuous effort should be directed towards updating knowledge and digital education of professional staff in solving the challenges faced by companies through the integration of information technologies in all enterprise sectors.

With the increase in information abundance, companies become dependent on the implementation of new changes in the management system. Changing technology is causing the nature of jobs to change. Information technologies are replacing jobs and drastically change the requirements towards them.

Researcher L. Pascari remarks that information technologies refer to the process of knowledge and its methods of application, processing, transfer, and realization of information. The information system includes the collection, organization, storage, publication, and use of information in the form of sound, graphic image, text, number, using the computer and telecommunication tools [12].

On the other hand, D. Oprea, D. Airinei, M. Fotache, 2002, appreciate that the important changes resulting from the information technology sector have become the source of basic changes in business management. The most important changes are rooted in the fact that

technology has allowed managers to highlight the necessary information and monitor the work of their employees [11, p. 124].

In recent years, research in the field of management amplifies the importance of information technologies for business success. In 1998, research carried out by the Nolan-Norton Institute showed that the use of information technologies in management is reflected by the quality of the new managerial methods applied [12].

At the same time, researchers D. Oprea, D. Airinei, M. Fotache, 2002, appreciate that information technologies remain a tool that makes changes in the nature of work, integrates organizational duties and contributes to stimulating organizational competitiveness [11, p. 128].

The use of information technologies can reduce transaction costs through electronic data transactions and shared databases, can eliminate intermediaries in organizational processes. The use of computers and communication equipment offers the possibility of sharing data, images, sound and even video sequences.

According to researchers G. May, I. Barletta, B. Stahl, M. Taisch, 2015, energy management is defined as "a combination of industrial methods applied in business management to help make optimal use of energy resources for the efficient processing of tasks" [7, pp. 48-51].

On the other hand, M. Melo, L. Bueno, S. Campello, 2012, point out that energy management represents an evaluative perspective of the management of the energy system and it is important to evaluate and produce the efficient use of energy in order to maximize profits as well as to enhance competitive positions, through organizational measures and optimization of energy efficiency in the process [8, pp. 10-11].

In the same context, R. Kannan, W. Boie, 2003, appreciate that an efficient energy management is an essential tool both for saving energy costs and limiting the impact on the environment. The decisive factor for the effective implementation of energy efficiency is a proper energy management [6, pp. 946-948].

According to researchers L. Young Eal, L., K., Kyoo-Kun, a good management of energy consumption saves energy itself, on the one hand, as well as it is necessary to achieve the majority of technical energy-saving measures. Energy management, from any perspective approached, deserves attention from a triple perspective: financial, social, and environmental [16, pp. 1151-1154].

The continuous increase in the demand for energy resources on the international market has deepened the problem of efficient management of energy consumption, on the agenda of most states of the world. In terms of business, energy is vital as one of the fundamental input elements in almost every sector. Therefore, energy costs directly affect the profitability of an enterprise.

It is clear that countries that can keep their energy costs low offer their companies a competitive advantage [8, p. 12]. In this context, there is a strong relationship between the security of electricity supply of countries and their national security. The strong relationship means that when there is an inadequacy of energy supply, economic and political stability will deteriorate concurrently.

Researcher Thumann, A., 1998, in his works, appreciates that natural gas, even though it has more affordable production costs and shows less carbon emissions compared to coal or oil, being increasingly preferred in past fifty years, identifies various sector problems such as outdated infrastructure, unsafe transactions due to third-party inclusions, price fluctuations. This situation endangers the sustainability, therefore the security of the energy supply. In order to survive in the mentioned circumstances, both companies and countries develop various strategies and try to contribute to their sustainability, to achieving energy efficiency. Governments implement numerous strategies to ensure uninterrupted, affordable, and sustainable availability of required energy, called national security of energy supply. One of these strategies is the diversification of supply sources. It refers to the diversification of both primary energy sources used and suppliers for import [15].

M. Melo, L. Bueno, S. Campello, 2012, reiterate that countries aim to avoid dependence on investment in different sources of energy production and focus on importing from various suppliers and through various intermediaries. In addition to diversification, the development of relevant projects for the effective implementation of energy management is another crucial strategy applied to ensure the security of energy supply [8, p. 14-15].

It is worth noting that countries, which do not lack fossil energy resources and mostly must obtain these resources through imports, tend to focus on saving energy consumed and energy efficiency, as well as increasing investment in distribution efficient use of electricity, through the implementation of information technologies. For example, EU countries, which have a sensitivity to environmental pollution and climate change, express significant efforts in saving energy and achieving energy efficiency to encourage projects to reduce their greenhouse gas emissions to zero in the long term.

Another common strategy is to reserve energy resources through both production and import as strategic reserves [8, p. 16].

Energy management in the Republic of Moldova faces multiple problems:

- dependence on electricity supply sources;
- outdated technical equipment of electricity distributors;
- electricity losses at electricity distribution system operators [4].

According to the researcher C. Gribincea, “energy management in the Moldovan vision uses more engineering and economic principles to control the costs of energy consumed, than managerial principles”. At the same time, the author of the paper points out that “...the new concept of energy management includes performing at least once a year the analysis of energy consumption in the territory in order to determine the possible interventions for the efficiency of energy consumption and the creation of a qualitative and independent energy audit system for all final consumers, including to identify potential measures to improve energy efficiency” [4].

According to researcher D. Oprea, the impact of information technologies in energy management is extremely significant, contributing to the reduction of costs, as well as to the efficiency of the processes of enterprises in the energy sector [10]. Thus, the implementation of information technologies in the energy sector can offer multiple benefits to enterprises in the energy sphere, such as:

- streamlining the production and transportation processes of electricity;

- reducing electricity losses in the transportation process;
- reducing the reaction time of dispatchers in the event of interruptions from the electricity connection system;
- streamlining the registration of electricity supplies;
- streamlining the communication with electricity consumers;
- streamlining the intervention of the dispatch team in case of exceptional situations.

At the same time, companies in the energy sector have the opportunity to implement various modern technologies in order to improve the efficiency of the operational management of electrical networks such as:

1. Software elements implemented within the electrical enterprise;
2. Artificial intelligence designed to optimize response time from the enterprise team and to streamline processes;
3. Hardware elements designed to record possible disconnections, power losses, to store the information in dispatches, etc.;
4. Internal power grid management applications;
5. OMS electrical network management systems [12].

Following the research carried out, we can highlight that "the modern concept of energy efficiency management is based on the integrationist idea of management, associated with the reasoning of the valorization of energy and industrial value chains in the context of sustainable economic development, as well as the new challenges of the business environment at national and global level regarding compliance with the principles of eco-responsibility and sustainable development in ensuring the level of competitiveness related to the rules of the competitive economy" [4].

In order to make the energy management of the electricity distribution system operators more efficient, to identify the problems and challenges faced by the electricity distribution operators in the Republic of Moldova, we consider it relevant to carry out a case study based on the largest energy distributor electricity from the Republic of Moldova, "Red-Nord" JSC.

The *goal* of the research is rendered by researching the role of information technologies in the efficiency of the operative management of electrical networks on the example of the "Red-Nord" JS company.

Adjacent research objectives are:

O1: elucidation of the factors of the operational management efficiency of electric networks;

O2: evaluation of the operative management efficiency of the "Red-Nord" JS company;

O3: identification of the information technologies implemented within the "Red-Nord" JS company;

O4: highlighting the digital transformation prospects of the "Red-Nord" JS company.

3. Methods and applied materials

In order to carry out the study, a set of methods were applied. The epicenter of the research was focused on the empirical analysis, targeted on elucidating the role of information

technologies in the efficiency of the operative management of electrical networks. In order to carry out the research, multiple data sources were used, such as:

a. *Specialty literature* – in order to substantiate the theoretical benchmarks of the work, studies from international databases were analyzed, related to energy management and the impact of information technologies in its efficiency;
b. *Reports of state bodies (ANRE)* – in order to analyze the research topic, the authors resorted to the analysis of the activity reports of the National Agency for Energy Regulation, which helped us to collect the data and to carry out a comparative analysis of the results obtained by the operators of the electricity distribution system in the Republic of Moldova;
c. *Internal reports of the "Red-Nord" JS company* – in order to substantiate the practical part of the study, we analyzed the internal reports of the "Red-Nord" JS company, which are available on the company's official website. The company's financial statements, management reports, technical-economic indicators, the investment plan, etc. were analyzed.
d. *The legislative documents in the field of energy* – in order to carry out the work, the legislative documents in the energy domain of the Republic of Moldova were analyzed to be able to understand the essence of the functioning of the energy sector, as well as the strategic objectives of the sector.

In order to research the theoretical approaches of energy management, we used, as a research method, *analysis and synthesis*, *induction and deduction*, which helped us to define the theoretical concepts, as well as to draw relevant conclusions.

On the other hand, we can mention that another method used in order to elaborate the paper was the *content analysis*, which resides in the analysis of ANRE reports, the internal reports of the "Red-Nord" JS company, the collection of data and their interpretation, with the formulation of relevant conclusions and recommendations aimed at making the operative management system of system operators in the Republic of Moldova more efficient.

The methods used were complemented by the *comparative analysis* of the analyzed indicators, on different electricity distribution companies, which helped us to identify the level of the energy management system development of operators of the electricity distribution system in the Republic of Moldova.

4. Results and discussions

Energy management in industrial enterprises is closely related to other types of management: production process management, production logistics, environmental management, and human resources management.

The human factor represents one of the most important factors with a decisive impact on the achievement of energy efficiency within enterprises in this sector. The competence, training, motivation, and involvement of human resources are the main pillars through which companies can achieve energy efficiency.

A decisive role in ensuring the efficiency of the management of a company in the energy sector belongs to the operational management of electrical networks by the dispatch service.

According to the Rules for the Technical Operation of Electric Networks NE2: 2020, approved by ANRE, each employee of the energy companies in the Republic of Moldova, "...must ensure the appropriateness of the arrangement and operation of equipment, buildings and constructions, electrical networks NE1-02: 2019 "Safety standards for the operation of electrical installations", approved by ANRE decision no. 394/2019 and the Technical Regulations "General Fire Protection Rules in the Republic of Moldova" RT DSE 1.01-2005, approved by Government Decision no. 1159/2007" [3].

At the same time, according to the provisions of ANRE, the personnel working within the energy companies are divided into 4 categories: electrotechnical, electro-technological, inspection, auxiliary, and non-electrotechnical personnel. Each of these categories has certain obligations to meet the qualification requirements, which require the continuous training of employees.

At the same time, according to ANRE, the operational management of the electrical networks is ensured by the dispatching service, which provides for the existence within the energy company of the dispatching service that is responsible for ensuring the continuity of electricity deliveries, checking the voltage, adjusting the machines, fixing the technical faults of the technical equipment [3].

The dispatch service within an energy company is divided into 3 levels:

- energy system dispatcher;
- electrical network dispatcher;
- service staff of the station, electrical network area dispatcher [3].

Each of the dispatchers is responsible for drawing up multiple technical record books.

Table 1. Registers filled out by energy company dispatchers

Category of dispatchers	**Registers filled out**			
Energy system dispatcher	Operational scheme of execution	The Register of requests for equipment decommissioning	The Register of protection by relays, automations and telemechanics	The Register for the record of the works performed in the electrical installations based on the authorizations and work provisions
Electrical network dispatcher	Daily execution operational scheme	The Register of requests for equipment decommissioning	The Register of protection by relays, automations and telemechanics	The Register for the record of the works performed in the electrical installations based on the authorizations and work provisions
Electrical network area dispatcher				

Source: elaborated based on the Activity Reports of ANRE [3]

From the data in the table, we notice that the dispatchers draw up and make entries in multiple registers in order to record various deviations, decommissioning of some equipment, some records regarding the measurement of voltage in the electrical network. In addition, the dispatchers are responsible for ensuring the efficiency of the delivery of electricity in the dispatch centers in the territorial areas. Thus, if there is a more complex structure of the energy company, then the dispatch service is divided into:

- central dispatch service – is the central dispatcher that ensures the efficiency of electricity supplies at the national/regional level. The central dispatcher is responsible for ensuring uninterrupted deliveries, rectifying delivery delays and technical problems that may occur in the network.
- regional dispatch service – usually, it is subordinated to the general dispatcher, but it, in turn, has subordinated the local dispatchers in the region. Thus, the regional dispatch center is responsible for the continuous supply of electricity to the local dispatch centers, but also continuously cooperates with them in order to ensure optimal working conditions in order to prevent certain shutdowns, technical problems.
- local dispatch service – are the dispatch centers located in urban/rural localities that are responsible for the delivery of electricity, the technical condition of the equipment in those localities.

The close cooperation between the dispatching services, the records in the technical documents, the record of all irregularities, deviations, helps to achieve and increase the performance of the dispatching service.

The essence of the operation of dispatch services is shown in Figure 1.

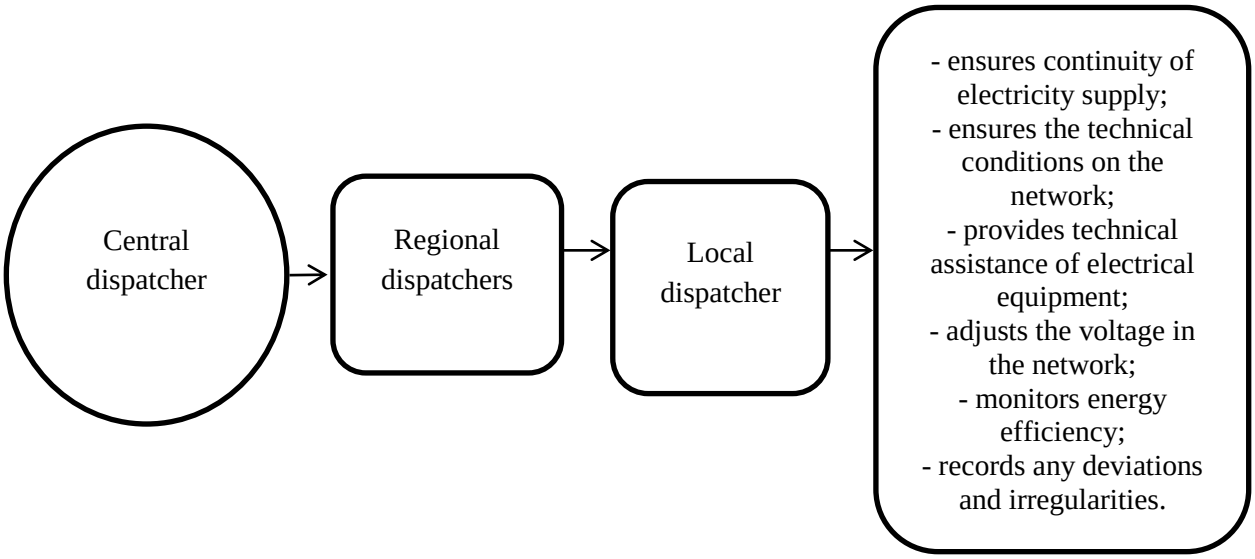

Figure 1. The role of dispatch centers in the efficient management of electrical networks
Source: elaborated by the authors

From the data in the figure, we notice that the dispatch service ensures the efficiency of electricity delivery to all the necessary points. Thus, the employees of the dispatching services must be competent persons, who have passed the following trainings:

1) NE1-02:2019 “Safety rules for the operation of electrical installations”, approved by the ANRE decision no. 394/2019;

2) Norms for the arrangement of electrical installations (further on – NAIE);
3) Technical regulations "General fire protection rules in the Republic of Moldova" RT DSE 1.01-2005, approved by Government Decision no. 1159/2007, "Fire protection rules for electric power companies";
4) production instructions and job descriptions;
5) occupational health and safety instructions [3].

At the same time, the Technical Director of the energy company is the person responsible for ensuring the continuity of the company's electricity supply. The efficiency of the company, the technical condition of the equipment, etc. largely depends on his competence.

According to the ANRE provisions, the technical director of an energy company is responsible for:

1) directing technological processes;
2) organizing the supervision of the technical condition of equipment, buildings and constructions;
3) the elaboration, organization, and record of the fulfillment of the measures that ensure the safe and economic exploitation of the object;
4) investigation and record of all operational violations;
5) control over compliance with the requirements of normative-technical documents regarding operation, repair, and adjustment [3].

At the same time, the Technical Director of the energy company has under his command the dispatching services that are responsible for ensuring the continuity of the company's electricity supplies. In this sense, he is responsible for the elimination of irregularities, violations by the staff of the dispatch service. Thus, the dispatch centers of the energy companies are equipped with automatic recording equipment. In this context, the records of the calls of employees from the dispatch services are kept for 10 days, in normal situations, and in special cases, breakdowns, operational irregularities, they are kept for 90 days [3].

For dispatcher control to be effective, the following conditions must be met:

– it should be based on a reasonable groundwork of the production schedule and calendar plans;
– the control during production should be performed based on operational data;
– the dispatch service must be equipped with the necessary equipment;
– the staff of this service should be equipped with the necessary equipment for the current regulation of the production process.

The form of dispatcher regulation and its methods largely depend on the type of production/delivery. This control is carried out in connection with the implementation of daily programs, in shifts and timetables. Current control and regulation is primarily aimed at the fulfillment of the program and related tasks.

The performances recorded by the employees of the dispatch service are punctuated by the satisfaction of the company's consumers, by the quality indicators recorded by the employees of the dispatch service, due to the fact that the employees of this service ensure the uninterrupted delivery of electricity to final consumers.

The company that distributes electricity in the northern region of the Republic of Moldova is "Red-Nord" JSC, a company founded on 03.11.1997, based on the Decision of the

Government of the Republic of Moldova no. 628 of July 8, 1997. Later, based on Government Decision no. 605 of July 26, 2017, regarding the reorganization of some joint-stock companies, the process of merger by absorption of RED "Nord-Vest" JSC by "Red-Nord" JSC took place at the enterprise, according to the minutes of the general meeting of 30.10.2017.

During the 25 years of activity, "Red-Nord" JS company managed to modernize its electricity distribution lines, technical equipment, increase the length of its electricity distribution lines and to reduce the average duration of power outages.

The general activity indicators of "Red-Nord" JS company, in dynamics, are shown in Table 2.

Table 2. General activity indicators of the "Red-Nord" JSC, 2017-2022

Indicator	2017	2018	2019	2020	2021	2022
The number of consumers of the company, of which: a. Household consumers b. Non-household consumers	490930 461203 29727	491227 460481 30746	490885 460857 30028	490801 460699 30102	492366 461253 31113	492586 461221 31365
Electricity consumption rate: a. Household consumers b. Non-household consumers	476,487 371,589	485,245 375,418	499,311 386,02	512,205 376,835	529,435 414,385	494,041 405,322
Average electricity consumption per consumer, kWh	116	119	124	143	96	89
Total length of power lines (0.4 kV), km, of which: Length of low-voltage power lines (0.4 kV), km Length of high-voltage power lines (6-10 kV), km	22232,186 14652,349 7579,837	22468,712 14635,148 7833,564	21875,7 14572,17 7303,2	22047,52 14666,3 7381,22	21457,63 14071,23 7386,39	21316,29 7381,35 13934,94
The total capacity of the transformers, MVA	976,6	977,2	978,5	994,58	995,4	1021,98
Investments, lei: CAPEX / km of power lines built	110393,68 9 440,743	129129,130 486550	1580050,610 542,240	2378228,89 440,743	273948,80 634,443	204913,2 943,51
SAIDI – average outage time index	177	201,95	143	83,82	93,96	83,95
SAIFI – the average frequency of outages	2,4	2,74	2,33	1,65	1,99	1,67
CAIDI – average duration of an outage for the final consumer, minutes	73	74	62	51	57	50

Source: elaborated based on the "Red-Nord" JSC activity reports, 2017-2022

From the data in the table, we can see that the "Red-Nord" JS company has increased its total number of consumers over the years. Therefore, it went from 490,930 consumers served in 2017, to 492,586 consumers served in 2022. Thus, if we were to analyze in dynamics, we can observe an increase with during the period of 2017-2022, by 3,4%.

In addition to this, we must note that the average consumption per consumer, in the period of 2017-2022, registered an oscillating trend, with a decreasing tendency. If, from 2017 to 2020, there is an increase in the average consumption per consumer, from 116 kWh, in 2017, to 143 kWh, in 2020, then in 2022, the average consumption per consumer decreased, to 89 kWh, or by approximately 23% compared to 2017. This fact is due, in large part, to the pandemic crisis and the energy crisis, which affected this sector and disrupted the activity of companies in this sector.

At the same time, we can note that the length of the electricity distribution lines also increased, during the analyzed period. If in 2017, the length of the electricity distribution lines was 22232.186 km, then by 2022, their length of increased to reaching 21316.29 km, during the year of 2022.

During the analyzed period, we observe an increase in new power lines built by the company. Thus, if in 2017 the company built 440.743 km of power lines, then in 2022, the company built 943.51 km of power lines. We can see the continuous growth of electric power distribution lines throughout the analysis period.

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Along with the increase in the length of the electricity distribution lines, the company's investments in equipment modernization also increased. From the data in the table, we can see an increasing trend of investments allocated by the company in the modernization of equipment and electricity distribution lines. Thus, if in 2017, the company allocated 110,393,689 lei in the modernization of equipment, then in 2022, the value of investments reached 204,913.2 lei.

Analyzing the dynamics of the total capacity of the company's transformers, in the analyzed period, we can see that in 2017, the value of the indicator was 976.6 MVA, then due to modernizations, purchases of new technical equipment, repairs, the total value of the total capacity of the transformers reached the value of 1021.98 MVA, or an increase of about 5% is recorded.

In addition to this, we can note that in the period 2017-2022, there is a reduction in the average interruption time, the SAIDI indicator, which recorded a decreasing trend for the entire period of analysis. Thus, if in 2017, its value was 177, then in 2022, the value of the indicator was 83.95. This reduction is largely due to the implementation of information technologies in the company's activity, which allowed the operationalization of call recording and faster liquidation of interruptions.

In addition to this, the average frequency of interruptions, the SAIFI indicator, also decreased during the analyzed period within the "Red-Nord" JS company. Thus, if in 2017, the value of

the SAIFI indicator recorded the value of 2.4, then in 2022, the value recorded by the indicator was 1.67.

In the same context, we can note that the average duration of an interruption (CAIDI), within the company, during the period 2017-2022 also decreased. Thus, if in 2017, the average duration of an interruption was 73 minutes, then by 2022, the value of this indicator has reached 50 minutes. The results obtained by the company, in the period 2017-2022, denote the improvement of the company's activity, the speed of receiving calls and solving the problems of consumers of the "Red-Nord" JSC. At the same time, we can note the efficiency of the operative management of the company's electrical networks, which was made possible thanks to the implementation of information technologies that allow dispatchers to quickly report technical problems and to intervene quickly in smoothing disconnections.

In Table 3, we have shown the dynamics of the economic-financial indicators of the "Red-Nord" JSC, for the period of 2017-2022.

Table 3. The economic and financial indicators of the "Red-Nord" JSC, 2017-2022

Indicator/Year	2017	2018	2019	2020	2021	2022
Sales income	667345986	692067132	711735107	677633530	743544970	671186899
Cost of sales	487376869	526811445	505118062	640251966	591180841	631134172
Gross profit	116175878	165255687	206617045	38241814	112275699	110432617
Net profit	99340154	80515402	100412133	17946897	51581953	69350104
ROE, %	7,1	4,8	4,4	5,40	15,10	16,45
ROA, %	7,0	5,4	4,9	2,91	1,56	1,59
Absolute liquidity ratio	0,029	0,013	0,010	0,01	0,02	0,024
Total liquidity ratio	0,699	1,722	1,037	1,04	0,9	1,05
Solvency rate	7,7	10,2	8,6	8,59	8,19	8,56

Source: elaborated based on the "Red-Nord" JSC activity reports, 2017-2022

Analyzing the dynamics of the economic-financial indicators of the "Red-Nord" JS company, in the period of 2017-2022, we can see that the company recorded, in most of the economic-financial indicators, significant increases.

Analyzing the solvency rate, in dynamics, we can see that this indicator registered an increase from 7.7 in 2017, to 8.56 in 2022.

On the other hand, we can also notice a spectacular increase in the total liquidity rate, from 0.699 in 2017, to 1.05 in 2022.

Thus, analyzing the company's net profit, in the period 2017-2022, we can see a significant reduction from 99340154 lei in 2017, to 69350104 lei in 2022, a reduction of 29990050 lei, or approximately 30%.

Although the net profit is decreasing, in the analyzed period, the ROE indicator registered a significant increase in the period 2017-2022. Thus, if the value of the indicator in 2017 was 7.1%, then in 2022, the value of the indicator reached the value of 16.45%.

The results obtained by the company, denote the efficiency of the operational management of the electric networks by the company, and point to the significant contribution of the

implementation of information technologies within the company, which allowed the efficiency of the company's activity and the increase in the speed of service to the company's consumers.

A significant contribution in ensuring the increase in the performance of the "Red-Nord" JS company was provided by the company's dispatch service, which ensures the efficiency of the operative management of electrical networks [14]. Thus, the main object of activity of the dispatch service of the "Red-Nord" JSC is the operative management of the 10/0.4kV electrical networks. The operational activity carried out by the employees of the dispatch service consists in monitoring the set of lines, installations, and electrical equipment 10/0.4kV, which starts from the departures from the electrical stations of the "Moldelectrica" SE to the customer's delimitation point final.

Starting from 2018, the management of the "Red-Nord" JSC organized a restructuring and optimization of the operative management of the electrical networks according to the European models of operative management, as well as multiple information technologies were introduced in the activity of the operative management of the electrical networks. Thus, the dispatching service was restructured from 15 territorial dispatching subdivisions of the company in which the main dispatcher and 5 other dispatchers worked in each subdivision, major changes were made and 3 CDPs (Central Dispatch Points) remained, in which 5 people work [14].

Until the implementation of the reforms, 15 local dispatch points operated within the company, for each branch, where 5 dispatchers were active in shifts and the superior dispatcher, a total of 90 dispatchers. Starting from 2018 until now, 61 people are involved in the dispatch service, which includes dispatchers and employees from the 24/24 customer service group.

By the competence of the employees of the dispatch service of the "Red-Nord" JSC depends, in large part, the efficiency of the electricity supply of the end consumers, the lack of electricity outages, the quick resolution of technical problems arising in the electricity networks.

Operational management of high voltage lines (10 kV) is carried out by dispatchers from the Central Dispatch Points within the company. The personnel employed in the Central Dispatch Point work 24/24, in 12-hour shifts, managing the 10kV electrical installations operatively. The dispatch service within the "Red-Nord" JSC consists of 15 dispatchers, psychologically evaluated, who are annually examined and authorized, and once every 5 years they perform trainings and improve their knowledge within the training center of the "Moldelectrica" SE.

The "Red-Nord" JSC has 3 central dispatch points with the following service areas:

1. CDP1 - Balti, Floresti, Glodeni and Riscani.
2. CDP2 - Falesti, Singerei, Rezina and Ungheni.
3. CDP3 - Briceni, Donduseni, Drochia, Edinet, Ocnita and Soroca [14].

The main activity of dispatchers is reflected in the operative register, SAIDI data, authorization register, fault register, and for effective communication, urgent information is placed in Viber, including the morning report.

Operational management of low voltage lines (0,4kV) is ensured by the LVDP (Low Voltage Dispatch Point) in each office activating a LVDP dispatcher with a normal working schedule of 8 hours. These particular dispatchers operate the office from 7:30 a.m. to 4:00 p.m. on working days, and outside of working hours, the operational control is transmitted to the LVDP, that operates 24/24, exception being the office of Balti, Ungheni and Donduseni, where the dispatchers work 24/24, in 12-hour shifts, managing the 0.4kV electrical installations operatively, with 5 dispatchers per shift and a superior dispatcher, the service area being the following:

1. LVDP Balti - Balti, Floresti, Singerei, Rezina
2. LVDP Ungheni - Ungheni, Falesti, Glodeni, Riscani
3. LVDP Donduseni - Donduseni, Briceni, Drochia, Edenit, Ocnita, Soroca.

Within the "Red-Nord" JS company, in the last 5 years, major changes have occurred in the implementation of information technologies. Thus, in the period of 2017-2021, various innovative software was implemented, such as:

1. The "24/24 customer service group" (Call center) was implemented – in the call center, 13 employees work in 12-hour shifts, and depending on weather conditions and other factors, they can simultaneously work up to 6 employees, but not less than two employees per shift. The main factors that led to the organization of the "24/24 customer service group" with the aim of making the activity more efficient in serving customers, are the following:

- ✓ centralization of some activities carried out in order to improve the efficiency of human resources;
- ✓ implementation of the "Non-Stop" telephone service (Call Center) for receiving information about deviations, related to the distribution of electricity;
- ✓ implementation of the telephone service for handling customer complaints;
- ✓ notification of the non-domestic customers by phone about the date and duration of the scheduled interruption of electricity supply;
- ✓ implementation of a new high-performance computer system for processing the customer's calls.

At the same time, the creation of the "24/24 customer service group" (Call center) facilitated an enormous reduction of pressure from customers on dispatchers during the breakdowns.

2. The SCADA/OMS system was implemented – the SCADA/OMS system is an information system to support the relevant operational activities and functions used in the automation of electricity distribution at the level of dispatch centers and control rooms. With the implementation of this SCADA/OMS system, the control of all equipment and installations related to the medium voltage (MV) and low voltage (LV) networks of the "Red-Nord" JSC was achieved. With the implementation of this information system, there have been also improved the information made available to the dispatch center operators, as well as to the staff of the field teams, to the management. This generated an efficient exchange of information between the dispatch centers and the call center. The SCADA/OMS system offers the possibility to monitor in real time, through specific interfaces, the energy equipment of the "Red-Nord" JSC. However, we must note that a problem that disrupts the efficiency of the activities in the implementation of the system is the fact that only 30% of the equipment can be remotely controlled, and a large part (70%) of the total number of equipment lacks in remote control, and for incoming information into SCADA /OMS, the positioning of the switchgear is done manually by the dispatcher.

3. The Smart Metering System was implemented (remote record of electricity consumption) – the main task of the project is the design of a complex set of equipment, software and accessories for the formation of the system of collection, transmission, saving and processing of data from smart electronic meters, installed at household consumers in residential blocks, individual houses and at technical records, as well as and to non-domestic consumers being connected/supplied from the same transformation point (TP). This system is therefore an Automated Measurement System.

The main components of the Smart Metering System:

- smart electronic meters (with RS-485 interface) installed at electricity users;
- data concentrators that have a role of collecting data read from electricity meters/meters installed at electricity users and their transmission to the central system;
- gateway – with the role of collecting data from the concentrators (in cases where the concentrators according to the SMS architecture do not send data directly to the central server but only through gateways) and their further transmission to the central system (central server) through GSM technologies/ LTE/GPRS or through a dedicated line (telephone, optic fiber, etc.);
- central system with roles of data collection from concentrators/gateways and their transmission to the electricity supplier, drawing up reports with the role of identifying areas that require optimization from the perspective of electricity supply.

4. The information system of planned records was implemented – the implementation of the information system offered the possibility to digitize the operative management process by means of planning the disconnections that are to occur in the near future. Thus, it allowed emergency employees to streamline their work, record all disconnections and warn customers that in the coming period technical works will take place and, respectively, they will have disconnections from the network.

The efficiency of the dispatch service within the "Red-Nord" JSC company can be evaluated through the quality indicators of the operative management of electrical networks, registered by the company (Table 4).

Table 4. Quality indicators recorded by OSD, 2017-2020

	FCE "Premier Energy Distribution" JSC				**"Red-Nord" JSC**			
	2017	**2018**	**2019**	**2020**	**2017**	**2018**	**2019**	**2020**
A	1	2	3	4	5	6	7	8
Total Scheduled Outages	16230	14687	11402	11933	10441	10656	10841	11140
Unannounced scheduled outages	0	0	14	58	0	0	0	0
Requests for the release of the approval for connection to the electrical network of distribution of electrical installations of potential final consumers (10 days)	6727	6741	9243	8016	3921	3161	3497	4052

A	1	2	3	4	5	6	7	8
Requests for the release of the approval for connection to the electrical network of power plant distribution (30 days)	121	136	318	514	0	11	149	176
Number of connection requests	11422	12569	12840	15501	2509	2342	1795	2287
Number of final consumers connected within more than 2 days	15	12	4	0	0	0	0	0
Compensation amount, lei	576,13	243	353	0	0	0	0	0
Total number of consumers reconnected	11480	9740	14349	6919	10848	10526	8091	6947
Number of consumers reconnected within more than 2 calendar days	5	3	5	3	0	0	0	0
Amount of compensation paid, lei	78,25	173	207	601,2	0	0	0	0

Source: ANRE Reports, 2017-2021 [3]

Analyzing the data in Table 5, we can see that the electricity distribution system operator FCE "Premier Energy Distribution" JSC registered an increasing trend of scheduled unannounced outages, from 0, recorded in 2017, to 58 unannounced outages, recorded in 2020. On the other hand, the "Red-Nord" JS company, for the entire analyzed period, did not register any unannounced disconnections, in the period of 2017-2020.

In the same context, we can mention that the electricity distribution system operator FCE "Premier Energy Distribution" JSC registered an increasing trend of compensations paid, in the period 2017-2020. If in 2017, the operator paid 78.25 lei in compensation to its consumers, then in 2020, the value of the indicator reached 601.2 lei. On the other hand, the system operator the "Red-Nord" JSC, for the entire analysis period, did not pay compensation for its consumers. This denotes the seriousness, the promptness of the reaction of the "Red-Nord" JSC to consumer calls and the promptness of the actions taken by dispatchers from the company's operational management system.

Following the research carried out, we can mention that through the reform of the dispatching service, the implementation of information technologies in the operative management of electrical networks within the "Red-Nord" JSC, the company managed to become more efficient, competitive and react faster to the requests received from its consumers.

5. Conclusions

Towards the end, based on the results of the research carried out, we can mention that the efficiency of the operative management of electrical networks represents a strategic approach for every operator of the electricity distribution system. In the Republic of Moldova,

according to the existing regulations, the operational management of the electrical networks is ensured by the dispatch service of the electricity distribution companies.

a. Following the research carried out in this paper, we can observe that the quality indicators of operative management within the "Red-Nord" JSC are growing, for the period of 2017-2022. Thus, in the period 2017-2022, there is a reduction in the average interruption time, the SAIDI indicator, which registered a decreasing trend for the entire analysis period. Thus, if in 2017, its value was 177, then in 2022, the value of the indicator was 83.95. This reduction is largely due to the implementation of information technologies in the company's activity, which allowed the operationalization of call recording and faster liquidation of interruptions. In addition to this, the average frequency of interruptions, the SAIFI indicator, also decreased during the analyzed period within the "Red-Nord" JSC. Thus, if in 2017, the value of the SAIFI indicator recorded the value of 2.4, then in 2022, the value recorded by the indicator was 1.67. At the same time, we can note that the average duration of an interruption (CAIDI) has also decreased within the company, in the period 2017-2022. Thus, if in 2017, the average duration of an outage was 73 minutes, then by 2022, the value of this indicator has reached 50 minutes. The results obtained by the company, in the period 2017-2022, denote the improvement of the company's activity, the speed of receiving calls and solving the problems of the "Red-Nord" JSC consumers. At the same time, we can note the efficiency of the operative management of the company's electrical networks, which was made possible thanks to the implementation of information technologies that allow dispatchers to quickly report technical problems and to intervene quickly in smoothing disconnections/ outages.

b. Analyzing the economic-financial indicators of the "Red-Nord" JS company, we can observe that in the period of 2017-2022, the enterprise recorded significant increases in most of the economic-financial indicators. Analyzing the solvency rate, in dynamics, we can see that this indicator registered an increase from 7.7, in 2017, to 8.56, in 2022.
On the other hand, we can also notice a spectacular increase in the total liquidity rate, from 0.699 in 2017 to 1.05 in 2022. On the other hand, analyzing the net profit of the company, in the period of 2017-2022, we can see a significant reduction from 99340154 lei, in 2017, to 69350104 lei, in 2022, a reduction of 29990050 lei, or approximately 30%.

c. Carrying out a comparative analysis of the two electricity distribution system operators, we can highlight that the electricity distribution system operator FCE "Premier Energy Distribution" JSC, in the period of 2017-2020, recorded an increasing trend of scheduled unannounced outages, from 0 unannounced outages recorded in 2017 to 58 unannounced outages recorded in 2020. On the other hand, the "Red-Nord" JS company, for the entire analyzed period, did not register any unannounced outages, in the period of 2017-2020. In the same context, we can mention that the electricity distribution system operator FCE "Premier Energy Distribution" JSC registered an increasing trend of compensations paid, in the period 2017-2020. If in 2017, the operator paid 78.25 lei in compensation to its consumers, then in 2020, the value of the indicator reached 601.2 lei. On the other hand, the system operator "Red-Nord" JSC, for the entire analysis period, did not pay compensation for its consumers. This denotes the seriousness, the promptness of the reaction of the "Red-Nord" JSC to consumer calls and the promptness of the actions taken by dispatchers from the company's operational management system.

d. In the last 5 years within the "Red-Nord" JSC, in order to improve the operational management system of the electrical networks, the following changes have been made:

- *the "24/24 customer service group" (Call center) was implemented* – 13 employees work in 12-hour shifts in the Call center, and, depending on the weather conditions and other factors, up to 6 employees can work at the same time but not less than two employees per shift.
- *the SCADA/OMS system was implemented* - SCADA/OMS refers to real-time information systems and all elements necessary to support the relevant operational activities and functions used in the automation of electricity distribution at the level of dispatch centers and control rooms.
- *the smart metering system (remote record of electricity consumption) was implemented* **–** the main task of the project is the design of a complex set of equipment, software and accessories for the formation of the system for collecting, transmitting, saving and processing data from smart electronic meters, installed at household consumers, at apartment blocks, individual houses and at the technical record, as well as at non-household consumers being connected/supplied from the same transformation point (TP). This system is therefore an Automated Measurement System.
- *the information system of planned records was implemented* – the implementation of the information system offered the possibility to digitize the operative management process by means of planning the disconnections/outages that are to occur in the near future. Thus, it allowed emergency employees to streamline their work, record all disconnections and warn customers that in the coming period technical works will take place and, respectively, they will have disconnections from the network.

However, we believe that the operative management of the electrical networks within the "Red-Nord" JSC must be further made more efficient through consolidated efforts carried out annually, through the lens of increasing investments in new information technologies, in order to equip the equipment, as well as through the infiltration of digitization in all company processes.

Thus, we consider it necessary to implement within the "Red-Nord" JSC of the following ***recommendations****:*

a. Streamlining the system of receiving calls from end consumers – in order to increase the response speed from operators in the Call center, it is necessary to implement a specialized software, namely interactive voice response, also known as *IVR (Interactive Voice Response)*. Traditionally, customers seek assistance from customer service specialists in person (such as when visiting information desks) or over the phone by calling a dedicated customer service number. But with the advent of new technologies such as interactive voice response systems and the increasing prevalence of online support resources such as frequently asked questions or live chat options on a company's website, customers may rely less on these personal interactions and more on self-service.

b. For more effective operation and increased network management, it is considered appropriate **to update and expand the existing SCADA/OMS system by modernizing the software and integrating more and more functions and possibilities.** For example, the installation of software applications for planning and dispatching the maintenance of

distribution networks, namely the module for strict record keeping of authorizations and work dispositions. This module will be linked with the application, where the personnel in charge of the corresponding production sectors will have the possibility to fulfill the authorization or work order directly from the phone or personal computer. After the authorization will be drawn up properly and signed with the electronic signature, it will reach the dispatcher through protected channels. Next, this authorization or disposition will be automatically recorded, the dispatcher will check the correctness of the formation of the authorization. After verification this authorization or provision will be registered and will receive a unique and centralized code. After receiving the unique code, it will be possible to perform work tasks according to the steps listed in the authorization or provision with direct reporting to the SCADA/OMS system from the user's mobile phone.

c. Implementation of electronic registers in the dispatch sector – in order to improve the efficiency of the operational management of electrical networks within the "Red-Nord" JSC, it would be beneficial the integration of the Operative Electronic Register, which is currently filled in by hand. For this change to benefit the dispatcher, all operational commands and permissions need to be routed directly from the SCADA/OMS system and not over the phone. All switching devices in the non-SCADA system are equipped with (open/ closed) or (connected/ disconnected) buttons. For the electronic register to be functional, it is necessary, in addition to the existing buttons, to have the teams in the field, which will be able to execute the maneuvers so that the dispatcher will indicate the switching device, the status and the team that must execute the maneuver, and the command it will come directly as a tablet workload in the field to the appropriate executor.

On the other hand, all the teams, which have the right to operational maneuvers, must be equipped with tablets, in which the tasks will be executed. At the moment of execution of the maneuver, the operative person will check the completion of the task, and the automatic SCADA/OMS system will indicate the new position of the switching device, informing the dispatcher about the execution of the command.

When executing the work planned by the authorization or disposition, the automatic admitter will receive your authorization on the tablet, after its verification, by the dispatcher and ask you for permission to prepare the workplace, admit and complete the work from the application, where earlier the issuer registered the authorization, and the dispatcher will accept the requests submitted from the SCADA/OMS with the respective changes in the SCADA Operating Scheme (OS) and the automatic registration in the operative register and authorization register. It is necessary for the issuer and other interested parties to have access for tablet viewing of the Operating Scheme (OS) from the SCADA directly on the tablet.

The tablets must be provided with all the necessary applications, including the geolocation programs, where the "Red-Nord" JSC network will be included, to help new operatives react quickly and promptly to the dispatcher's requests.

d. Integration, in the existing SCADA/OMS information system, of a mobile switching module, which is also called Mobile Switching Orders (*Mobile Switching Orders*) – it is a web application, which, using the MMI (Man Machine Interface) or the HMI (Human Machine Interface), will allow remote updating of non-SCADA switchgear (open/ closed) directly by the field/ operating teams.

e. Restructuring of the dispatching service by absorbing the low voltage dispatching points – in order to digitize the operative management of electrical networks within the "Red-Nord" JSC, on the one hand, but also to reduce the number of dispatchers, operational expenses, but also to increase the automation of processes, on the other hand, we come with the proposal to implement another reform of the dispatching service by absorbing the low voltage dispatching points by the central dispatching points (CDP1, CDP2, CDP3).

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Rezumat

Prezenta lucrare reprezintă o incursiune metodologică privind elucidarea aportului factorului uman în eficientizarea gestiunii operative a rețelelor electrice. Scopul lucrării este redat prin cercetarea rolului tehnologiilor informaționale în eficientizarea gestiunii rețelelor electrice pe exemplul companiei S.A. „Red-Nord". În vederea atingerii obiectivului general al cercetării, au fost analizate principalele tehnologii informaționale care pot fi aplicate în gestiunea operativă a întreprinderii energetice. Totodată, au fost trecute în revistă regulamentele ANRE privind eficientizarea gestiunii operative a rețelelor electrice, cu elucidarea rolului dispeceratelor în gestiunea operativă a rețelelor electrice. Drept urmare, au fost analizați principalii indicatori de activitate ai companiei S.A. „Red-Nord", precum și indicatorii de gestiune operativă a rețelelor electrice în perioada 2019-2021. Totodată, au fost trasate concluzii și recomandări privind eficientizarea gestiunii operative a rețelelor electrice prin prisma dezvoltării factorului uman și introducerii tehnologiilor informaționale.

Metodele de cercetare utilizate în vederea elaborării prezentei lucrări sunt: analiza și sinteza, inducția, deducția, cercetarea empirică, analiza comparativă, care ne-au ajutat să identificăm aportul factorului uman în gestiunea operativă a rețelelor electrice.

În concluzii, putem remarca faptul că în ultimii 5 ani, compania S.A. „Red-Nord" a implementat softuri moderne în vederea eficientizării gestiunii operative a rețelelor electrice, precum: sistemul informațional al înregistrărilor planificate, implementarea sistemului SCADA, reorganziarea sistemului de dispecerat. Totuși considerăm necesară realizarea următoarelor optimizări: eficientizarea sistemului de recepție a apelurilor, perfecționarea softului SCADA/OMS în vederea introducerii de noi funcții care ar permite reducerea timpului de răspuns din partea companiei către consumatorii finali.

***Cuvinte-cheie**: tehnologii informaționale, management energetic, gestiune operativă a rețelelor electrice, energie electrică*

Аннотация

Научная работа представляет собой методологический анализ нацелен на выяснение вклада информационных технологии в эффективность оперативного управления электрическими сетями. Цель статьи заключается в исследовании роли информационных технологий в эффективности управления электрическими сетями на примере компании S.A. «Red-Nord». Для достижения общей цели исследования были проанализированы основные информационные технологии, которые могут быть применены в оперативном управлении энергетической компании. В то же время были пересмотрены положения НАРЭ об эффективности оперативного управления электрическими сетями с разъяснением роли диспетчеров в оперативном управлении электрическими сетями. В результате были проанализированы основные показатели деятельности компании S.A. «Red-Nord», а также показатели оперативного управления электрическими сетями в период 2019-2021 гг. При этом, были сделаны выводы и рекомендации по эффективности оперативного управления электрическими сетями через развития человеческого фактора и внедрения информационных технологий.

Методами исследования, использованными при подготовке данной статьи, являются: анализ и синтез, индукция, дедукция, эмпирическое исследование, сравнительный анализ, что позволило выявить вклад человеческого фактора в оперативное управление электрическими сетями.

В заключение можно отметить, что за последние 5 лет компания S.A. «Red-Nord» внедрила современное программное обеспечение для повышения эффективности оперативного управления электрическими сетями, такие как: информационная система планово-предупредительного учета, внедрение системы SCADA, реорганизация системы диспетчеризации. Однако, мы считаем необходимым провести следующие оптимизации: повысить эффективность системы приема звонков, доработать программное обеспечение SCADA/OMS с целью внедрения новых функций, позволяющих сократить время ответа от компании до конечных потребителей..

***Ключевые слова:** информационные технологии, энергоменеджмент, оперативное управление электрическими сетями, электроэнергетика*

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