DECISION MAKING MODEL OF INTRODUCING ENERGY-SAVING TECHNOLOGIES BASED ON THE ANALYTIC HIERARCHY PROCESS

Tetiana Hilorme, Oles Honchar Dnipro National University
Kostyantyn Tkach, Odessa National Polytechnic University
Oleksandr Dorenskyi, Central Ukrainian National Technical University
Olga Katerna, National Aviation University
Akmal Durmanov, Tashkent Institute of Irrigation and Agricultural Mechanization Engineers

ABSTRACT

A hierarchical tree of the levels of choosing the optimal information and communication means for promoting energy-saving technologies based on the hierarchy analysis method was built, including 4 levels of criteria: type of consumer; economic indicators of consumer opportunities; means of promotion available for perception; tools that have a direct impact on the consumer. This hierarchical system allows the selection of the optimal communication means of promoting energy-saving technologies. The communication system for promoting energy-saving measures was formalized as a set of real and potential threats to the choice of management decisions to ensure an adequate level of support for energy saving measures.

Keywords: Energy-saving Technologies, Analytic Hierarchy Process, Hierarchical Tree of Decision Making, Integrated Communications

JEL Classifications: C20, C50, G21

INTRODUCTION

The problem of energy saving and the transition to technologies that allow partially or fully abandon the use of gas and other fossil organic fuel is a priority in Ukraine today. By consuming traditional energy sources using outdated technologies for energy supply of residential, recreational and industrial buildings, Ukraine spends 3-4 times more fuel per unit of GDP compared to developed countries. The introduction of new engineering and design solutions in energy supply systems that provide for the integrated use of renewable energy (solar and geothermal energy, environmental heat, etc.) will solve the important economic and scientific and technical problem of reducing the consumption of traditional fuel and energy resources for Ukraine. This corresponds to the energy strategy of Ukraine for the period until 2030 and other legislative documents. The new edition of the European Union Directive on the energy performance of buildings points to measures which implementation will bring the sphere of energy supply services closer to the requirements of European countries. The most important direction of these activities is the construction of buildings with minimal energy consumption, which will achieve a high level of energy efficiency.

The entry of Ukraine into the European zone requires the adoption of European rules for improving the energy efficiency of buildings and ways to implement them. In order to

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form a European mentality with domestic consumers, intermediaries, suppliers, and other participants in market processes, appropriate communication should be carried out to create and promote innovative energy-saving technologies in Ukraine. However, a set of issues related to the determination of domestic specificity of the introduction of a modern model of promotion requires in-depth analysis and methodological clarification. It is becoming more and more difficult for energy companies to determine which set of communication tools for creation of long-term market relationships and achievement of optimal impact on the consumer is effective.

REVIEW OF PREVIOUS STUDIES

The current state of development of the market shows that the best results are achieved by the complex use of several means of communication or means of promotion, namely the use of integrated communications (IMK) (Drobyazko et al., 2019a;b).

IMK is a concept for planning communications, based on the need to evaluate the strategic role of each of its elements in a promotion strategy, to find their optimal combination to ensure a clear and consistent impact of the company's communication programs to promote innovative technologies, particularly in the field of energy-saving technologies (Hilorme et al., 2019a), Hilorme et al., 2019b; Hilorme et al., 2019c.

The integration processes of various communications form integrated communications as an integral system of enterprise activity, aimed at extracting the maximum economic and social benefit from the available resources synthesizing various tools and principles of communication processes management (Yang et al., 2017).

That is why to accomplish the task you need a close interaction of various departments of enterprises (Park & Kwon, 2017), which implies first of all coherent communications within the company and a huge arsenal of various means for creating and maintaining communications with the external environment (Chel & Kaushik, 2018); Makedon et al., 2019).

It is the entry into the multidimensional communication space, or a complex of communications, forms its true value, which ensures its investment attractiveness (Wang et al., 2017).

Enterprises constantly search for new means of promoting energy-saving technologies on the market, which is why the question arises of how to identify the method of determining the optimal information and communication tool.

METHODOLOGY

The following general scientific methods were used during the study: system analysis, grouping (when developing a scheme of hierarchical levels and components); analysis, logical generalization; Analytic Hierarchy Process method (when building a hierarchical tree of levels for selecting the optimal information and communication means of promoting energy-saving technologies); graphical for clarity of presentation of study results.

The Analytic Hierarchy Process (AHP) is primarily focused on building models of choice in a finite set of previously known alternatives.

The concept of this method is that the decision-making task is structured by building a multi-level hierarchy that includes components (hierarchy focus, selection criteria, alternatives), which are compared with each other in order to obtain assessments of the intensity of mutual influence, which are used to assess the advantage of alternatives relative to the main goal.

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The advantages of AHP as an integrated method for modeling multi-criteria decision-making problems are: hierarchy building is based on the principles of a systematic approach and helps to avoid gaps in the model; structuring of decision-making tasks and formalization of the links between its components; the method allows for the assessment and comparison of alternatives using non-measurable (qualitative) subjective criteria; AHP stability in minor violations of consistency (transitivity) of expert judgments.

The complexity of the use of AHP lies in a significant number of interactions between components of the hierarchy, which have different degrees of importance.

RESULTS AND DISCUSSIONS

The most effective promotion in the market of energy-saving technologies is a complex impact - integrated communications with the consumer. The level of correspondence of communication tools and consumer desires should be a criterion for choosing the effectiveness of funds. But to analyze all aspects of the impact of means of promotion on consumers of energy-saving technology projects is problematic, primarily because of the large amount of input data and the lack of information that will allow you to create an information and communication space. In such cases, the system for assessing the effectiveness of the implementation of energy saving measures, its information and communication component. We propose to divide the system for assessing the effectiveness of communication tools, to single out independent hierarchical subsystems based on the AHP method.

At the same time, it is necessary to build 4 levels of criteria for selecting the optimal communication medium: the first- type of consumer (A); the second- the economic indicators of the consumer's capabilities (B); the third- accessible for perception means of promotion (C); the fourth- tools that provide a direct impact on the consumer (D). The perception of means of promotion (introduction) of consumer energy saving measures is influenced by various factors that are unequal, which create many alternative solutions.

The set of information and communication tools (alternative solutions) to promote the energy-saving technologies of the enterprise S consists of elements of four subsets based on the T. Saaty hierarchy analysis method:

$$S = A \cup B \cup C \cup D \qquad (1)$$

Where, A-set of consumer types; B-set of economic indicators of the consumer's capabilities; C-accessible for perception means of promotion; D-tools that provide a direct impact on the consumer.

Based on the analysis of the multiple factors influencing the attitude of consumers to the means of promoting energy-saving measures, it is necessary to know the maximum demand for such information and communication tools that will ensure the maximum degree of achievement of its communication. The method of analyzing hierarchies allows building branched hierarchical structures (Figure 1).

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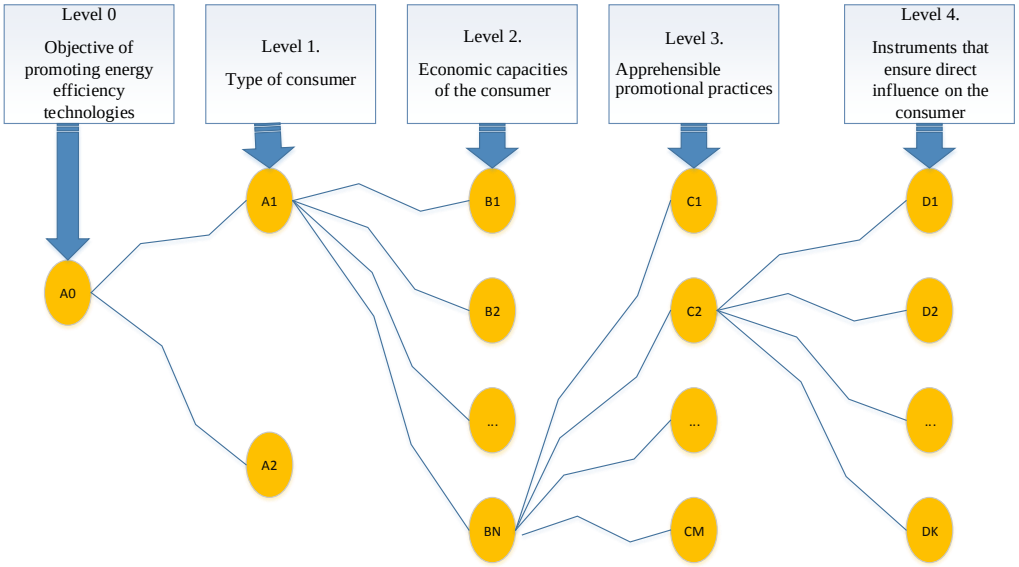

FIGURE 1
HIERARCHICAL TREE OF LEVELS OF CHOICE OF THE OPTIMAL INFORMATION AND COMMUNICATION MEANS OF PROMOTING ENERGY-SAVING TECHNOLOGIES BASED ON THE HIERARCHY ANALYSIS METHOD

The first level is determined by the type of consumer according to its activity to consume information in communications. It is proposed to classify it in active (independently searching for information and provides feedback communication impact on the process of consumption and promotion) and passive- the information on the promotion is reflected in a random form. In this case, from the standpoint of the development of increased interactivity of communication, it is necessary to devote more effort to the passive consumer.

The second level is determined by the criterion-economic indicators of the consumer's opportunities. In order to determine these key criteria of opportunities, in our opinion, it is necessary to use a methodology that includes the calculation of internal and external threats to make decisions-strategic analysis (PEST-analysis and SNW-analysis). As alternatives, there may be segments in terms of income and education, and in the future it will determine the quality of perception of the means of promoting energy-saving technologies.

The third level determines the criterion of accessibility for the perception of means of promotion- knowledge of energy-saving technologies and the degree of confidence in them. The fourth level is the criteria of tools that provide a direct impact on the consumer (alternative means of promotion).

The justification of the choice at each level should be determined using the T. Saati expert matrix, for example, the criterion "Economic capabilities of the consumer" is determined by the rule of pairwise comparison (Equation 2):

$$\left\{\begin{array}{c} B_1 = 2B_2, B_1 = 5B_2 \\ 2B_2 = 5B_3 \vee B_2 = {}^{5}/_{2B_3} \rightarrow \\ B_3 = 2/5B_2 \\ \frac{B_2}{B_3} = \frac{5}{2}, \frac{B_3}{B_2} = \frac{2}{5} \end{array}\right\} \quad (2)$$

Where, B_i ith value of the comparative factor

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Other criteria of levels 1-2, 4 are determined using such a comparison in accordance with formula 3. After calculations using formula 3, a matrix of pairwise comparisons is built in a table form. Then, for the subsequent building of a scalar chain, the factor that gets the maximum number of points in the "Matrix of pairwise comparisons" is determined.

But the choice of an effective means of promoting energy-saving technologies does not solve the problem of a synergistic effect of a company promoting energy-saving technologies to the market. To do this, it is necessary to create an organizational mechanism for information and communication support for the promotion of these technologies, that is, an organizational structure for managing the promotion process and management decisions in the system of this structure.

RECOMMENDATIONS

Based on the results of building a hierarchical tree of levels for choosing the optimal information and communication means for promoting energy-saving technologies based on the hierarchy analysis method, it is recommended to build a strategic map of goals (use software products, in particular MS Visio, Business Studio for ease in use, clarity and simplicity of calculations). The strategic map provides management with an effective energy efficiency management tool that allows us to transfer the organization's vision and its strategy into a set of interrelated balanced indicators that assess the risk factors and threats not only of the current, but also the future development of the enterprise. After building a strategic energy efficiency map, one should identify the main vectors and directions that will ensure this. This can be done by building the Ishikawa diagram (vectors - energy independence, energy security, reduction of energy costs).

Thus, for the implementation of successful and efficient management of the introduction of energy-saving technologies, it is necessary to implement an energy efficiency policy in accordance with a coherent strategy aimed at achieving clear goals for realistic work schedules and a set of modern measures of market communications.

CONCLUSIONS

The implementation of the methodological recommendations and the developed complex of optimal information and communication means for promoting energy-saving technologies will allow all agents of the energy market to successfully fulfill their needs, to form active economic behavior about decision-making. At moderate financial costs, this will lead to a significant effect of energy saving and the creation of new jobs. The prospects of such a direction are due to the fact that it is relevant for several adjacent branches of science: construction, industrial heat engineering, agricultural complex, and ecology. Only through integrated accounting of technical, technological, environmental and economic aspects the economic, scientific and technical problem of reducing the consumption of traditional fuel and energy resources can be solved in order to survive society as a whole.

The clear program for achievement of goals for a certain period of time sets the investors, performers and consumers specific tasks of creating alliances of communities and private investors. The agreed and joint efforts necessary to achieve the goals set will be effective in combining the efforts of communities and private investors, which will enable the management of planned projects to introduce energy-saving technologies and implement it in a short period of time.

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