Research on User’s Recommendation Method of Energy Saving Technology in the Context of Energy Saving Society

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Keywords: Evaluation method, Energy saving, Technology, Recommendation.

Abstract. Under the background of energy conservation and emission reduction in the whole society, the application of energy-saving technology is very important. In this paper, according to the energy-saving needs of customers, we study the recommended methods of energy-saving technology. Firstly, this paper constructs the evaluation index system of energy-saving technology. Then, based on the TOPSIS method, we get the priority of targeted energy-saving technology, and finally recommend it to users in order.

Introduction

Energy consumption customers play the main role in the energy-saving service system. In particular, some enterprises consume a lot of resources or energy in exchange for the growth of economic benefits, which goes against the concept of high-quality economic and social development. In the process of production and operation of enterprises, the problem of low energy efficiency occurs frequently, which wastes a certain degree of resources or energy while consuming costs. It is necessary to help enterprises reduce energy loss, save costs and reduce environmental pollution. After decades of extensive economic development, many enterprises, institutions and individuals have no awareness of saving electricity. In the context of economic restructuring and the development of energy-saving industry encouraged by the state, many enterprises, institutions and individuals in China have become customers of energy-saving services, such as construction units, steel enterprises, shopping malls, factories and so on.

State Grid Corporation of China undertakes the responsibility of scientific and energy-saving use of electricity, guides users to implement energy-saving projects, builds energy-saving service system, and ensures the completion of energy-saving indicators specified by the state.

State Grid Corporation of China has established a comprehensive energy service company to provide energy-saving services such as energy-saving diagnosis, design, financing, transformation and operation management in the form of contract energy management. It is an important work for comprehensive energy service companies to provide energy-saving solutions and help customers improve energy efficiency. How to recommend appropriate energy-saving technology to users to form a reasonable solution needs to be studied.

The evaluation method is very important for the energy saving effect of users. There are many literatures on evaluation methods. Literature 1 based on TOPSIS model to evaluate urban ecological construction in Jiangxi Province. In document 2, the combination weighting method and the improved TOPSIS model are used to evaluate the actual situation of the comprehensive development of urban ecology in Changsha. According to the calculation results of the evaluation analysis, the selected samples are sorted according to the advantages and disadvantages. Document 3 uses the improved TOPSIS model to evaluate the resource and environment carrying capacity of Anhui Province, and analyzes the internal factors that affect the resource and environment carrying capacity. In document 4, the weight value of each evaluation index is calculated by analytic hierarchy process, and finally, the building energy-saving technology which is currently suitable for Northeast China is selected by combining with engineering projects. In document 5, the comprehensive evaluation of energy-saving technology of air-conditioning system of railway passenger cars is carried out by
analytic hierarchy process. These evaluation methods have advantages and disadvantages, which need to be selected according to the specific situation.

Customer Energy Saving Technology Evaluation Index

First of all, carry out research on customer attributes. Then according to the customer's power load characteristics and production characteristics, carry out research and analysis. Secondly, reserve a large number of energy-saving technologies. According to the customer's energy-saving needs, evaluate the reserved energy-saving technologies, and finally find the most appropriate energy-saving technologies to recommend to customers.

The construction of indicator system needs to refer to certain principles. Here, smart indicator construction principles are adopted, including: specific principle, measurable principle, accessible principle, relevant principle and traceable principle.

The construction of index system is to reflect the nature, characteristics, structure and elements of specific evaluation objects. The evaluation index system of user demand responsiveness should select indexes according to its particularity.

Because the evaluation indexes have different dimensions, the evaluation should ensure that these indexes have a unified evaluation standard. The quantitative indexes are easy to measure. The qualitative indexes can be transformed into the quantitative indexes by constructing the same evaluation standard, which can also be measured.

The purpose of index system construction is to evaluate and analyze specific evaluation objects, so the evaluation results are highly dependent on the basis of index data. When designing index system, we should consider the accessibility of index data, so that we can have further analysis value, so we should consider the accessibility of each index in the design of index system.

Each index in the index system should be related to each other. The index system is composed of a group of indicators that have organic relations with each other, and there is a certain internal logical relationship between the indicators.

When designing evaluation indexes, it should consider whether the corresponding indexes are easy to track, monitor and control. Identify key energy-saving technologies and provide users with more economical and efficient energy-saving technologies.

According to the specific requirements of customers, it is necessary to evaluate from multiple perspectives and finally determine the adaptive energy-saving technology. According to the principles of accuracy, feasibility, combination of quantitative and qualitative evaluation criteria, an energy-saving technology evaluation index system is formed.

| First level indicator | Second level indicators | Third level indicators |
|-----------------------|-------------------------|-----------------------|
| User applicability    | Technical adaptability  | Whether the technology meets the user's requirements |
|                       | Economic endurance      | The comparison of technology and economy |
| Technology sustainability | Technological Development | Investment payback period |
|                       |                         | Initial investment |
|                       |                         | Sustainability of subsidy policy |
|                       | Technological competitiveness | Industry penetration |
|                       |                         | Technology life cycle |
|                       |                         | Technology economy without subsidy |
|                       |                         | Advanced technology |
|                       |                         | Security |
|                       |                         | Energy efficiency |

Table 1. Recommended scoring index of energy saving technology.

Briefly introduce the meaning of the following indicators:
User applicability evaluation index: judge whether the energy-saving technology meets the user's demand according to the customer's energy-saving demand. This index is the most important index. If it does not meet the user's energy-saving demand, the technical evaluation is unnecessary. The quantitative and qualitative analysis methods are used to select the evaluation indexes of economic tolerance. The economic comparison of different technologies is carried out under the condition of existing subsidies, and the local subsidy policies are tracked. The relevant policy documents will clarify the time limit of subsidy strength. And according to the actual situation, calculate the payback period and initial investment, the smaller the index, the better.

Evaluation index of technology sustainability: the strength of technology sustainability directly affects the sustainability of technology application. The evaluation of the degree of technological development should be carried out from both breadth and depth. The popularization type in the industry reflects the breadth of technological development, and the penetration rate in the industry reflects the depth of technological development. At the same time, the life cycle of technology should be considered. Technological competitiveness refers to the core competitiveness of technology, including advanced technology, economy, security and energy efficiency under no subsidy. In the case of no subsidy, it can truly reflect the economic competitiveness of technology. The energy utilization efficiency mainly uses energy saving, energy consumption, power consumption, etc. as the representation form.

Research on Recommended Methods of Energy Saving Technology

State Grid Corporation of China organizes and carries out research on key energy use technologies every year, sorts out key energy use technologies in different industries such as industry, construction, transportation and agriculture, and publicizes them.

In this paper, the evaluation indexes of energy-saving technology in key fields are selected for comprehensive evaluation. In the selection of evaluation methods, TOPSIS method is used for comprehensive evaluation. TOPSIS is a sort method of approaching ideal solution. The basic idea of modeling is: according to the existing data to build the positive and negative ideal situation of the evaluation object, using the distance model to calculate the distance between the evaluation object and the ideal point. In the process of evaluation, the distance from the negative ideal point is mainly used to measure the quality of the scheme. The larger the distance from the negative ideal point is, the better the scheme is. Using the weighted Euclidean distance formula:

$$ y_i = \sum_{j=1}^{m} w_j(x_j - x^*_j)^2 $$

Where $y_i$ is the distance, $x^*$ is the ideal point $x^*$ or $x^-$. The queue indicator value is used to measure the distance from the negative ideal point. The larger the queue indicator value is, the better the queue indicator value is:

$$ c_i = \frac{y^-_i}{y^-_i + y^+_i} $$

TOPSIS uses the relative proximity as the queue indicator. Relative proximity:

$$ d_j = \frac{\langle \Delta u_i, \Delta u \rangle}{\| \Delta u \|} $$

among them, $\Delta u_i = u_i - u^-_i$, $\Delta u = u^+ - u^-$, $\langle \Delta u_i, \Delta u \rangle$ is the inner product of sum.

$$ \| \Delta u \| = \left( \sum_{j=1}^{m} (u_j^+ - u_j^-)^2 \right)^{1/2} $$
Recommended Methods of Energy Saving Technology

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According to the assignment rules, some experts in the industry are invited in this study. According to the information provided and the rich experience and theoretical knowledge of the experts themselves, the importance of qualitative indicators is judged and scored. Because the comparison of the importance of indicators in AHP is obtained through expert opinions, but the single expert opinion has too big problem and low credibility. The final weight can be obtained by entropy weight method and index weight. In this paper, based on the entropy weight AHP method, TOPSIS method is introduced to evaluate the energy-saving technology. The positive and negative ideal points of energy saving technology can be determined by formula (2) - (3). TOPSIS method is used to evaluate and rank the priority of energy-saving technology projects. According to this order, recommend energy-saving technologies to users in turn, and implement energy-saving projects according to customers' opinions.

Summary

Based on the actual energy-saving demand, this paper studies the recommended method of energy-saving technology. In the actual implementation process, under special circumstances, there may be some problems such as unreasonable index evaluation, which needs further improvement.

Acknowledgement

This work is supported by Science and Technology Foundation of SGCC Research and development of key models for decision support of energy internet companies (NO. SGSDJY00GPJS1900057).

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