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Energy Efficiency Evaluation of Iron and Steel Enterprise

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Abstract: In order to optimize the allocation of energy resources, reduce enterprise's energy consumption and achieve the goals of energy conservation and emission reduction, energy efficiency evaluation indicator structure and evaluation method which are fit for iron and steel high energy consumption enterprise are proposed, an energy efficiency evaluation system is designed for iron and steel high energy consumption enterprise to simulate the dynamic behaviors of energy use and consumption during the production process. The system has the function of data acquisition, statistical analysis and prediction. During the coke oven production process, this system is applied to the process from coal material to coke cake, and its feasibility is shown. *Copyright © 2012 IFSA.*

Keywords: High energy consumption, Energy efficiency evaluation, Evaluation index, Evaluation system, Iron and steel enterprise.

1. Introduction

Highly energy consumption enterprise is the principal end user of energy consumption. Modeling enterprise energy consumption process and simulating the dynamic behavior of energy using are of great importance. It not only can realize the qualitative analysis and quantitative evaluation of enterprise energy consumption, but also is an effective means of enterprise energy efficiency evaluation. The key of simulation and analysis is the construction of model. Up to now, there have been input-output model, statistic regression analysis model, system dynamics model and system identification model for enterprise energy consumption analysis at home and abroad. To some extent, these methods, which mainly utilized the modern mathematical achievements, reflect the enterprise production scale and energy consumption status. Especially, input-output model, as a good tool for cost accounting and

analysis, can quantitatively reflects the consumption components of product, but it is on the foundation of historical data analysis to account the energy consumption, when the industrial structure and technology are changed, it hasn't the predictive ability, and meanwhile, input-output model can't directly reflect the production process [1]. System dynamics model occupies preferable predication performance in the system of society, economy and ecology, but it is unsuitable for the quantitative analysis of enterprise energy consumption process with diverse components [2]. Moreover, statistic regression analysis model and system identification model are usually used to build up the mathematical model of energy consumption equipment or unit energy consumption activity, but don't adapt to the global and complex process of enterprise energy consumption [3]. Anyhow, the above methods have their own advantages, but they can't establish the global and direct model of enterprise energy consumption process, which integrated with mathematical and visual character and reflecting the collaborative work between energy consumption activities.

Enterprise energy consumption process describes energy transfer in energy transmission pipe net and energy conversion through energy consumption equipment. It has the characteristics of obvious process, uncertainty, concurrence, and asynchrony etc. Most of the energy consumption processes are continuous; meanwhile, there are also some discrete events in it, such as the equipment start/stop. Aiming at the shortage of the means to evaluate enterprise's efficiency of high energy consumption of our country at present, from the angle of reducing emission and energy-conservation, energy efficiency evaluation index system of high energy consumption trade is set up at many levels of many angles, the energy efficiency index of quantization to examine can be offered, an objective basis achievement to examine in saving energy and reducing the cost for enterprises is offered. While the index system is studied, the enterprise energy consumption evaluation method on the basis of the model is studied, the integrated model of enterprise's energy consumption system through the study on production procedure is set up, the scientific and rational assessment means of the energy consumption in enterprise's production process are got using modern analysis and optimization technology of simulation and assessment, prediction analysis is offered for such enterprise's energy consumption as direct energy consumption, indirect energy consumption and complete energy consumption of the enterprise unit product, decision support is offered for enterprise's energy resources rational distribution, the balance of energy between energy supply and energy demand, high efficiency of energy utilization, data support is supplied for the fact that enterprises carry on real energy-saving and cost-reducing facilities and improvement, acquisition, disposition of energy-saving and cost-reducing decision .

2. Energy Efficiency Evaluation Index System for Iron and Steel Enterprise

According to the characteristics of energy consumption, the energy-conservation focal points of the iron and steel enterprise are optimization of production procedure and renewal of the equipment of mainly product consuming energy, comprehensive utilization of mainly product consuming energy, remaining energy recovery and energy pollutant. So, enterprise's efficiency comprehensive evaluation is considered from not only the economic benefits but also such different fields as the energy consumption activity management, production technology energy-conservation and environmental protection. Energy efficiency evaluation indexes are fellow the following principles of iron and steel high energy consumption enterprise.

Integrality principle: They reflect the true state of the energy consumption system of every enterprise as in an all-round way as possible.

Concise principle: The index concept is clear, the data are apt to examine, the effectiveness is strong.

Importance principle: It should be the important index in all fields, through reducing the total amount of indexes, enable investigating the economy of measuring is feasible.

Level principle: It should be able to reflect the inherent structure of enterprise's energy consumption system, so it must have certain level nature.

Comparability principle: In order to compare, the evaluation indexes are required to have certain comparability on the time and space.

According to above-mentioned principles, through analyzing the basic data materials of enterprises, statistical data of energy utilization of enterprises and production data that are easy to obtain and examine, energy efficiency evaluation index type of iron and steel enterprise is 4 parts, namely economic indexes, technical management indexes, energy management indexes and environmental efficiency indexes. Its index system is shown as Fig. 1.

1) Economic indexes: They include value of industrial output and value-added.

2) Technology management indexes: They include energy efficiency of production and exchange unit, energy efficiency of transportation and distribution unit, energy efficiency of product and energy efficiency of equipment consuming energy.

3) Energy management indexes: They include accomplishment ratio of energy supply plans, guarantee degree of stock volume to production at then end of term, proportion in good condition of the measuring apparatus, economy ratio of remaining heat recovery, energy-conserving potentiality, skill and investment of energy-conserving.

4) Environmental efficiency indexes: They include air pollutant displacement, water pollutant displacement, solid pollutant displacement and air quality.

Every index meaning is shown as following:

Total industrial output value reflects the total scale of industrial production and total level in certain time.

Economic value-added reflects the input, output and economic benefits situation of the industrial enterprise. It’s the basis to improve the production and management of industrial enterprise.

Energy efficiency of production and exchange unit, namely enterprises use the energy and change the energy production equipment energy consumption level, closely related to enterprise's efficiency level.

Energy efficiency of transportation and distribution unit is an important link of every terminal department, for most enterprises, the energy losses of transportation and distribution does not forms the main part of enterprises total energy losses, but has reflected the promotion level of energy-conserving potentiality.

Energy efficiency of product is an energy utilization ratio of the products, reflects the ratio of theory effective energy consumption to real net energy consumption producing the unit product.

Energy efficiency of equipment consuming energy reflects the proportion of total effective energy consumption of equipment to total amount of energy supplying.

Accomplishment ratio of energy supply plans is calculated according to the material object amount of energy mainly, analyzed the reason not hitting the target.

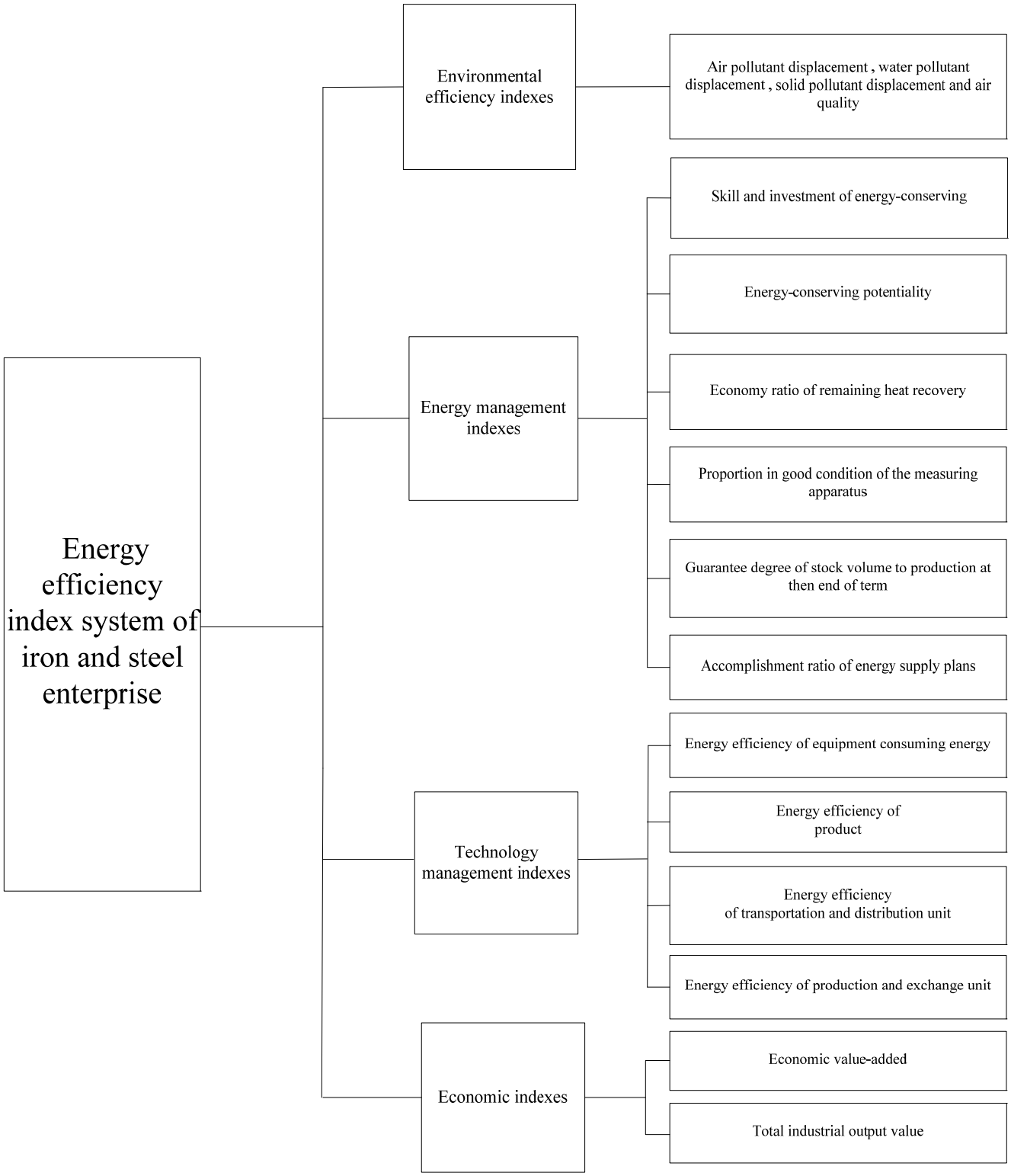

Fig. 1. Energy efficiency index system of iron and steel enterprise.

Guarantee degree of stock volume to production at then end of term is calculated according to some main energy material object amount and equipment generally, reflects the impact of energy stores change on economic result.

Proportion in good condition of the measuring apparatus can weigh the accuracy and feasibility of enterprise's energy data.

Economy ratio of remaining heat recovery reflects enterprise retrieve actually lost heat to economize the energy.

Energy-conserving potentiality is a goal that the energy-conservation demands to reach to reflect the disparity that actual efficiency compares with advanced level.

Skill and investment of energy-conserving, in order to reduce energy consumption, economize the energy, enterprises need to carry on technological transformation or reconstruct to some equipment, so the measure investment of the energy technology should carry on, this index reflects the economic benefits that the energy-conserving skill arranges.

3. Energy Efficiency Evaluation System for Iron and Steel Enterprise

Energy efficiency evaluation system for iron and steel enterprise is designed as following demand.

1) Data warehouse of energy information, namely data set facing theme, integration, relatively stable and reflecting history changes is set up, is used for supporting enterprise's energy administrative decision.

2) Evaluation index system of energy efficiency in iron and steel enterprise is established from such a lot of angles as energy resources, environment, enterprise's benefit.

3) Synthetically analysis of energy efficiency index is realized, using the system engineering method, variation tendency of energy consumption in enterprises and every department is predicted, structure of energy consumption of all products in every department is optimized, efficiency of energy consumption is improved, economic benefits and environmental benefit are comprehensive evaluated, support for making policy is offered.

The systematic structure frame is shown as Fig. 2, the function of every part is described as following.

Energy data warehouse is used for storing historical data and present data that the enterprise energy uses, it is divided into economic data of the enterprise and department, the supplies and products data, the equipment data of every department, every department working medium data, production technological process information, disposal of pollutants data.

Calculation of efficiency index, namely centering on economic energy efficiency index, products energy efficiency index, energy-conserving potentiality, environmental efficiency index, according to firsthand information and data of warehouse, adopting country normal computing technology, quantization appraises the individual event index of enterprise's efficiency.

Energy efficiency common index template. According to the trade characteristics of iron and steel high energy consumption enterprise, the efficiency index template of the trade is made, an efficiency index in common use to the trade is offered.

Energy efficiency index analysis. Using data mining technology, through excavating to the energy data warehouse, build the model is built to predict the variation tendency of the energy uses while one period, support is offered in energy plan decision.

System management includes user management, management of data storehouse and management of evaluation index.

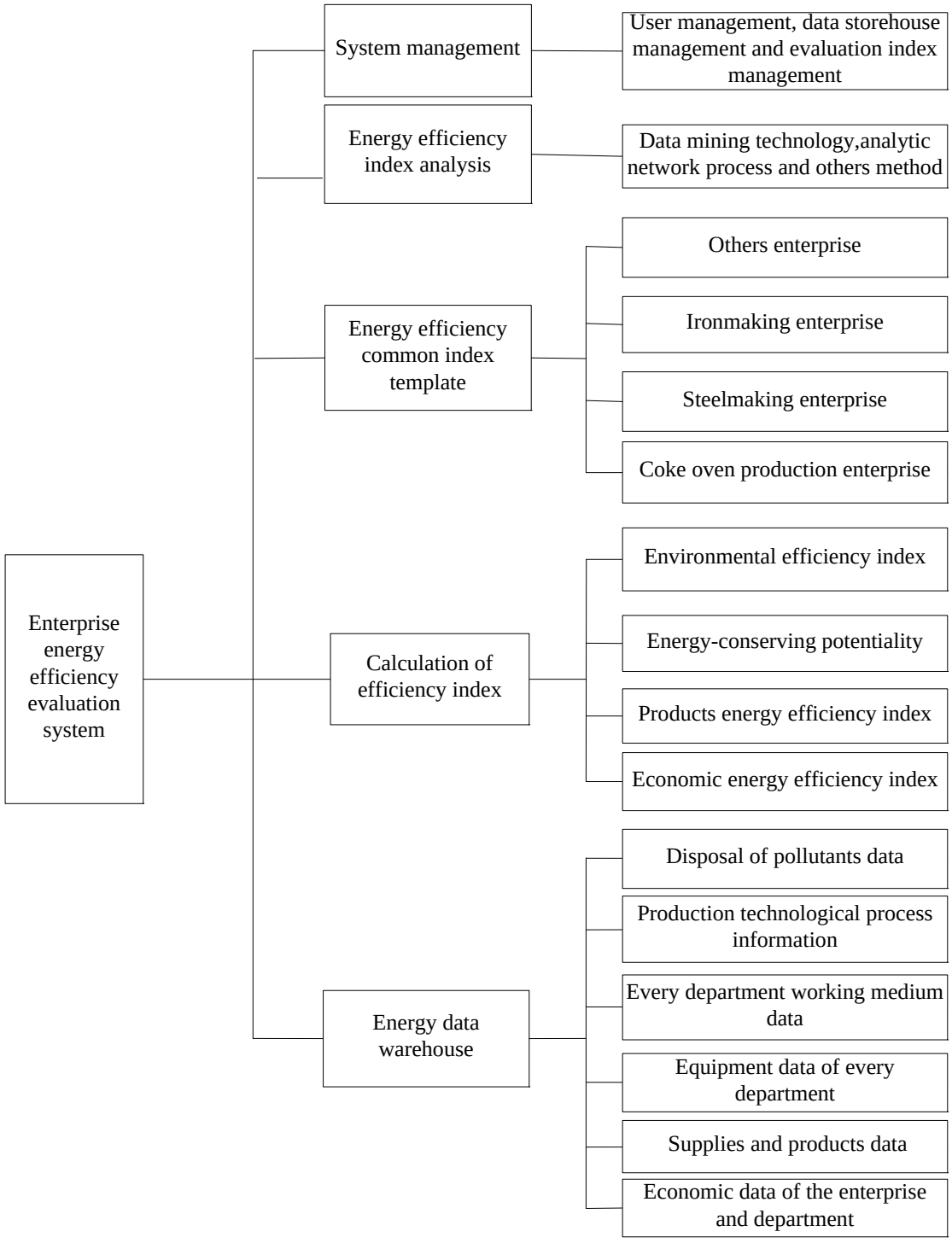

Fig. 2. Systematic Structure Frame of Iron and Steel Enterprise Energy Efficiency Evaluation.

This system has the following characteristics.

1) The basic operation of the figure user's interface is supported, for example users can fully understand, freedom handled, the systematic models of energy consumption is established in a flexible way;

2) Offering the communication frame that users defined every model element property.

3) Supporting the dynamic simulation of the energy consumption course, offering the corresponding simulation pictures.

4) Assessing the difference of indexes According to different energy efficiency evaluation index, energy efficiency evaluation result is produced by simulation.

5) Supporting graphics compared analysis of simulation result of different models.

4. Application for Coke Oven Production

Study and application of comprehensive assessment of energy efficiency in coke oven production process is carried on in order to verify its feasibility. The life cycle of this system is shown as Fig. 3.This system collects the primal production data at first, evaluation index system of energy efficiency is established, through analyzing, the integrated model of the energy consumption system is set up, then the simulation of systematic energy consumption is carried on. Evaluation of simulation result of the system according to energy efficiency evaluation index system, after making the efficiency evaluation value, making comparison with expected index, in order to obtain ideal value, optimization is got through the aid decision system, optimization result is obtained as feedback, energy consumption system integrated model is adjusted until expectation index that efficiency assesses is got [4].

The systematic operation result shows that the integrated model of system can describe the energy consumption system from stage construction, much angles, give full play to the visual advantage combining with analysis; The simulation method of enterprise energy consumption system based on model can offer a series of dynamic performance analysis datum of energy consumption system, as important basis of systematically analysis and optimization. The parameter disposition of energy consumption system is evaluated by energy efficiency evaluation method based on model, decision support is offered for high efficiency operation of energy consumption system. Application has verified the systematic feasibility of comprehensive evaluation of enterprise's efficiency of high energy consumption.

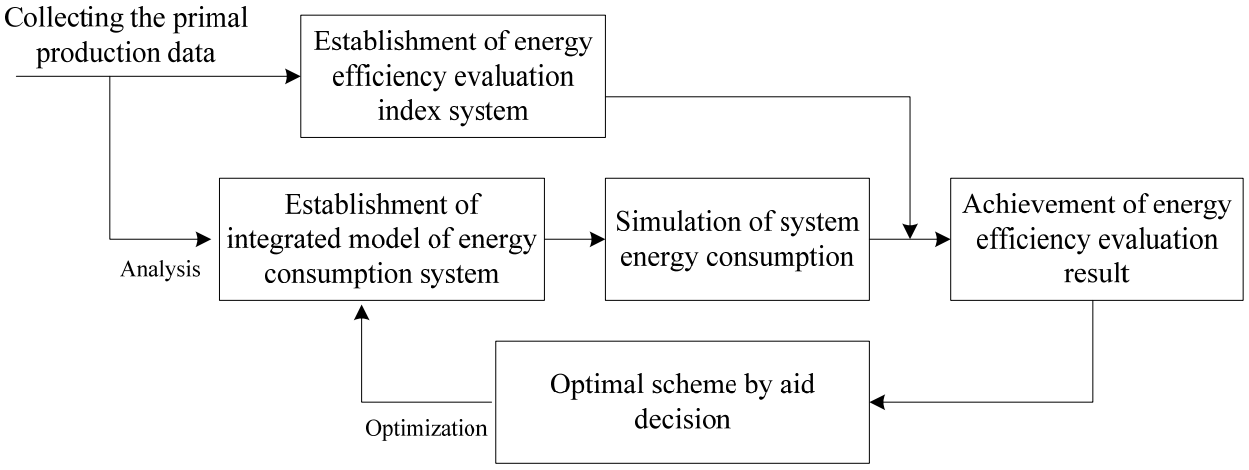

Fig. 3. Life Cycle of Cole Oven Production Energy Efficiency Evaluation Application System.

5. Conclusions

The industrial enterprise is a subject of energy consumption, energy-conserving potentiality is enormous, is necessary and urgent for enterprise's energy efficiency to carry on comprehensive evaluation. Using the analytical method of the system engineering, efficiency comprehensive evaluation index system and evaluation method has been put forward, enterprise's efficiency comprehensive evaluation system have

been designed, quantitative analysis and optimization means for high-efficiently energy use in high energy consumption enterprise are provided through launching enterprise's efficiency comprehensive evaluation of high energy consumption omni-directionally. It has remedied the deficiency of systematic enterprise energy development tactics, realized digitization and systemization of enterprise's energy efficiency evaluation, the obvious economic benefits to enterprises is brought. This method has the characteristics of science and succinct, can offer basis to the enterprise energy decision policy, thus improve the utilization efficiency of the enterprise energy.

Acknowledgements

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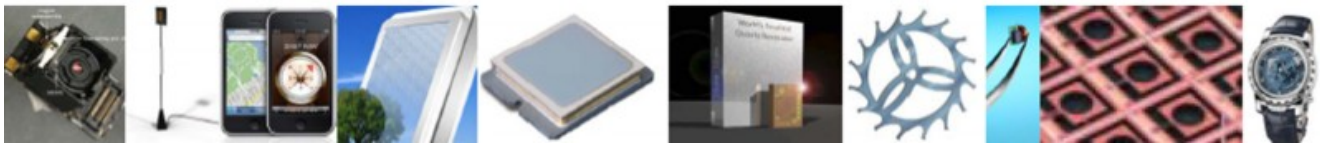

Sensors & Transducers Journal

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Sensors & Transducers Journal (ISSN 1726-5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because of it is a peer reviewed international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per year by International Frequency Sensor Association (IFSA). In additional, some special sponsored and conference issues published annually. *Sensors & Transducers Journal* is indexed and abstracted very quickly by Chemical Abstracts, IndexCopernicus Journals Master List, Open J-Gate, Google Scholar, etc. Since 2011 the journal is covered and indexed (including a Scopus, Embase, Engineering Village and Reaxys) in Elsevier products.

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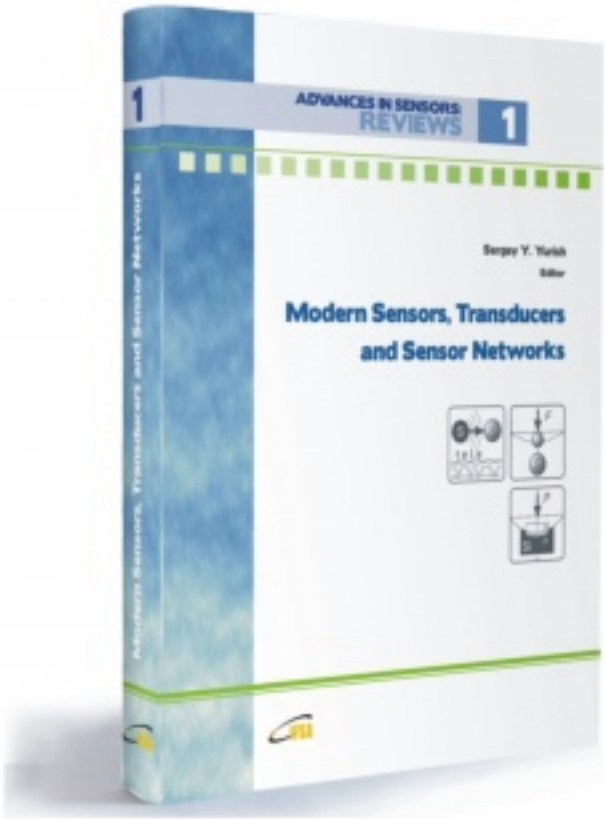

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