American Journal of Electrical Power and Energy Systems
2017; 6(4): 51-56
http://www.sciencepublishinggroup.com/j/epes
doi: 10.11648/j.epes.20170604.13
ISSN: 2326-912X (Print); ISSN: 2326-9200 (Online)

Research on Value Sharing Model of Energy Service Industry Value Network

Dong Jun, Lv Shanlei, Xie Shiyan, Dou Xihao

Department of Economics and Management, North China Electric Power University, Beijing, China

Email address:
1195188299@qq.com (Lv Shanlei), 609653526@qq.com (Xie Shiyan)

To cite this article:
Dong Jun, Lv Shanlei, Xie Shiyan, Dou Xihao. Research on Value Sharing Model of Energy Service Industry Value Network. *American Journal of Electrical Power and Energy Systems*. Vol. 6, No. 4, 2017, pp. 51-56. doi: 10.11648/j.epes.20170604.13

Received: June 25, 2017; **Accepted**: July 10, 2017; **Published**: July 31, 2017

Abstract: Energy service industry is a complex network system and a promising industry involving multi-subject, multi-product, multi-technology and multi-value. In this network, all the value network participators are correlative and the value appreciation constitutes value network. Value network is a new effective form of management for the industrial value chain, which can increase the added value of the value network. In the value network of the energy service industry, analyzing the relationship among those participators can help to solve the distribution problem and create more value. This paper built the value sharing model with energy service companies as the object. Then analyzed the relevant factors through fuzzy comprehensive evaluation method and analytic hierarchy process method. The example confirmed the feasibility and validity of the model.

Keywords: Energy Service Industry, Net Value, Value Sharing Mode, Fuzzy Comprehensive Evaluation Method

1. Introduction

Energy service industry is a complex network system and a promising industry involving multi-subject, multi-product, multi-technology and multi-value. The main participators include energy service companies, energy consuming enterprises, financial institutions, equipment suppliers, design organization, construction organization, third-party certification institutions and government supervision departments. Those interrelated participators provide a variety of energy efficiency products and services through a variety of energy-saving technologies, financing means and business models. The scope of energy services industry covers both energy consulting services and energy-saving technical services. Theoretically, the research on composition and distribution of energy service industry according to value network model and value sharing model can bring a new perspective to the development of the industry, which is helpful for a deeper understand of the key influencing factors, a deeper analysis on the role of market entities and a deeper study on benefits and business mechanism of the whole industry. On the practical sense, returning or evaluating the behavior of the entities in the process of industrial development from the value sharing and value contribution perspective can vitalize the energy service market. The market entities will be more active in the industrial network once they realize the value added from their actions. The cooperation in the optimal operation of the industry can guarantee the energy service projects carry out smoothly. Ultimately it will bring corresponding economic, environmental and social benefits and make greater contribution for the growth of the entire national economy.

Value network is a new approach for the enterprises to gain an edge in the competition and to enhance the value. The operational design will be put on the macro level in this way, which would contribute to the healthy development of the industry. Under the condition of value network, a reasonable value sharing proportion is an important driving force for the cooperation in the value network. So the research on the benefit sharing in the value network is necessary, which can help these companies make strategic decisions about value-related activities. Zhu Xuefei analyzed the financial management system of the energy service company from a perspective of value chain, on this basis the paper put forward energy service value model and built value chain framework [1]. Zhao Dan introduced dynamic alliance negotiation theory in the benefit sharing mechanism and used fuzzy comprehensive evaluation method to determine the risk

coefficient of each participant. Then the benefit sharing model between energy service companies and customers was available [2]. Liu Na analyzed the cooperative relations between the entites of energy service companies based on saring value theory [3]. Huang Zhixing had a research on decisions for investments of benefit sharing projects based on contract energy management model. He summed up the significance of contract energy management under the circumstance of benefit sharing [4]. Geoff Burrows, Christopher Black had a research on benefit sharing of six Australian accounting firms. They introduced three methods: average sharing, performance-based sharing, average and performance mix sharing [5]. Canes M E, France N used linear programming method to explore the special economic problems under the federal energy management [6]. Satyaveer S. Chauhan, Jean-Marie Proth proposed a supplier-retailer profit distribution model. The model assumed that the demand depended on retail price. If the price was infinite, then the demand was zero. In addition, they also proposed maximizing profit and profit distribution method based on respective investments [7]. Chen Jian built energy service value network using value network theory and had a research on value creation mechanism and value distribution strategy [8]. Zhang Xiangyang, Yang Mincai analyzed the risk and risk sharing principles in the supply chain. They also studied the risk sharing and benefit distribution mechanism in the supply chain [9]. Under the contract energy management mode, Huang Zhixing made a deep study of energy saving benefit sharing project investment decision-making, and summarized the significance of energy saving benefit sharing the contract energy management mode [10].

2. Value Network of Energy Service Industry

In the value network, energy service value network is a complete new form of organization. Energy service industry value network consists of stakeholders on the network node, namely, energy service companies, energy-consuming enterprises, government, grid companies, financing side, equipment suppliers, energy efficiency evaluation agencies, etc. The relationship between these nodes has a dynamic process of mutual influence and cooperation, resulting in value creation, distribution transformation and its structure. The Energy Services Industry Value Network enables energy services companies to integrate resources from energy services and expand the impact of them. The node element is the "gene" for value chain. The value chain is the "genome" that consists of a set of group elements according to certain rules. Industrial value network is a dynamic process that decompose and integrate a complex system. Through the decomposition and integration of the system genome, the complex system will be decomposed into multiple independent genomes. Then combine these independent genomes according to a connection rule and constitute a more complex value chain system through making a contract between them. Ultimately form a industrial value network. This value network is a macro cross-type organization including two levels:

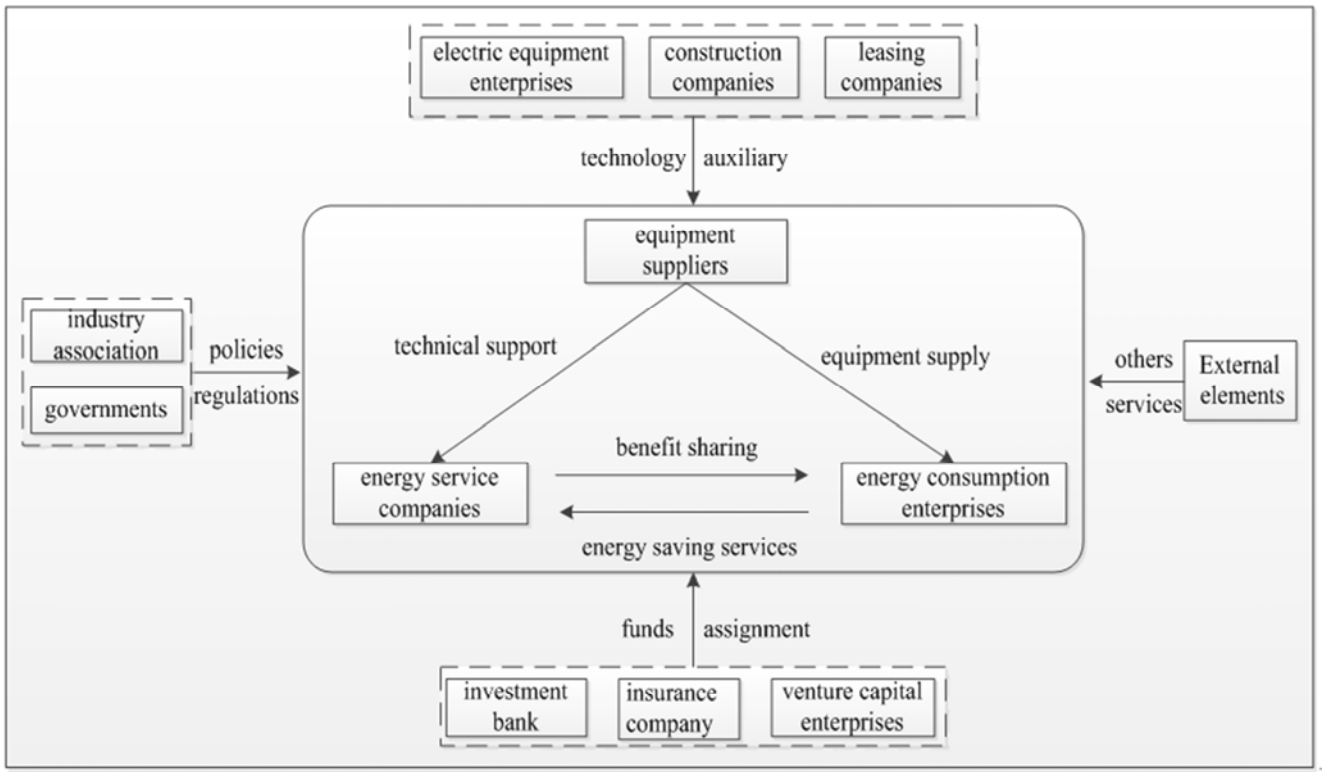

Figure 1. *Structure diagram of energy service industry value network.*

(1) internal value network. The competency of enterprises can be divided into core competency and general ability. As the scale of enterprise expanding, more complex market relations would be introduced into the internal modules of the organization. The internal value chain would extend, be integrated and be networking. The enterprises combined different value chains and value models with one or more core competencies as the center. So the internal value network system was formed.

(2) external value network between enterprises. To improve the competitiveness, the enterprises need to share resources and information and establish an interdependent relationship. Enterprises in different value chains have adopted a corporate alliance strategy in response to the impact of economic globalization. Businesses are connected and an intertwined value system was built for the mutual influence between enterprises, that was, external value network between enterprises.

Value network is a macro concept. It can be unified or be incessant. Energy service value network develops through the mutual influence and mutual cooperation between the elements above. The value of customer can't be achieved by the energy service companies alone It also need the cooperation from energy consumption enterprises, equipment suppliers, technical service providers and governments. For the energy service industry, its value network consists of energy service companies, equipment suppliers and energy-consuming enterprises. Energy service companies provide customers energy saving services and energy saving technological transformation to improve energy efficiency. Equipment suppliers as a link to energy service companies and energy consumption enterprises, will provide technical support for energy companies and equipment support for energy consumption enterprises. Other components, such as energy efficiency management platform, government agencies and financing side are the important constituent part in the value network to support the tripartite party. Therefore, the value network structure can be distributed as Figure 1:

3. Value Linkage Between Entities of the Energy Service Industry in the Value Network

Under the guidance of "customer centrality" trend, since energy consumption enterprises were the potential customers to the energy service company, there was a dynamic relationship between the main bodies and formed as choices and contract.

Energy service company – energy consumption enterprises – equipment suppliers

1. value linkage between energy service company and energy consumption enterprises.

The primary problem of this value linkage was service positioning and service proposition, in other words, identifying target customer or customer demand in order to clear the service objectives. Energy consumption enterprises usually dominated this service system. So the energy service companies must focus on their fundamental needs and interests and follow the principle "requirements are the pillars of goals". Only in this way can the energy service companies gain more profits from customers in terms of energy management contract. Service positioning and service proposition were ultimately reflected in objectives. The energy service company could develop service plans according to the diversity requirements from customers.

2. value linkage between energy service company and equipment suppliers.

Energy service companies chose equipment suppliers with same strategic objectives and corporate cultures. The index system was built to conduct a comprehensive assessment of operating efficiency, technical level and energy efficiency of the energy consumption enterprises. It could prevent the adverse selection. The energy service companies selected equipment suppliers to establish strategic cooperation with them, gain bargaining initiative and as far as possible to reduce the cost and increase sharing benefits

3. value linkage between energy consumption enterprises and equipment suppliers.

In order to make the service fit the requirements from energy consumption enterprises, the energy consumption enterprises were attracted to the supply process by energy service companies, and they would get the service in a "equipment alteration or substitution" way. Meanwhile, stimulating joining willingness of the equipment suppliers would promote the increase of group interest and bring about value flow.

Energy service companies – energy consumption enterprises – other stakeholders

1. value linkage between energy service companies and other stakeholders

There were two types of stakeholders: the first one had non-direct benefits, including the government which subsidized the enterprises and got tax, competitors and supplementary energy saving service provider. The second one could directly gain benefits from the market, including investors and partners. Energy services companies must cooperate and complete with other stakeholders to create value.

2. value linkage between energy consumption enterprises and other stakeholders

There was a certain intersection between energy service companies and energy consumption enterprises. The operating policy made by the investors may affect the purchase of energy saving services. However, the energy saving demand would directly affect the value of the companies and the benefits of the investors. At the same time, the acceptance of complementary services for the energy consumption enterprises could directly determine whether the enterprises could establish a long and steady cooperative relations. As energy consumption companies may also purchase alternative services, each market entity would consider the value of others

when maximizing their own interests.

4. Build Value Sharing Model and Determine Parameters

Assume there were m entities involved in sharing the energy saving benefits in the value network. $M = \{1,2,3,...m\}$ was the whole set, U was the total income, w_i was the quota for unit i, k_i was the allocation proportion for unit i, I_i was the resource coefficient, E_i was coefficient of effort for unit i, F_i was the risk factor for unit i, $(i = 1,2,3 \ldots m)$. The final sharing proportion of each entity depended on F_i、I_i、E_i. The distribution of each entity can be presented as follows:

$$w_i = Uk_i(E_i, F_i, I_i), \sum_{i=1}^{m} k_i = 1 \quad (1)$$

$$\frac{\partial k_i}{\partial E_i} > 0, \frac{\partial k_i}{\partial F_i} > 0, \frac{\partial k_i}{\partial I_i} > 0 \quad i = 1,2,\cdots,\mathrm{m} \quad (2)$$

According to formula (4-1) and (4-2), if the income of one entity $u_i = 0$, then the income of other entities were all 0; if the income of on entity $u_i > 0$, then the income of other entities were greater than 0. Then, the value these entities in the value network got could be presented as:

$$w_i = U\left[F_i \times I_i \times E_i \Big/ \sum_{i=1}^{m}(F_i \times I_i \times E_i)\right] \quad i = 1,2,3,\ldots\ldots,m \quad (3)$$

Then for the sharing value of entity i, its distribution ratio k_i was:

$$k_i = \frac{F_i \times I_i \times E_i}{\sum_{i=1}^{n}(F_i \times I_i \times E_i)} \quad i = 1,2,\cdots,\mathrm{m} \quad (4)$$

From formula (4-1), it could be concluded that the income obtained by the participants in the energy service industry network is in proportion to resource coefficient I_i, coefficient of effort E_i, and risk factor F_i. At this point, the definition of variables in the value sharing model of the energy service industry value network was completed. Then used fuzzy comprehensive evaluation theory and AHP to determine several parameters in the model, the specific implementation steps were shown as follows:

First, Identify the factors of contribution coefficient. Three indicators were mainly considered including working hours, attitude and cooperation. After defining the influencing factors of the efforts in the value network, fuzzy comprehensive evaluation method was used to determine the degree of effort of the participant.

The first step is to use AHP to determine the weight of each factor. This paper used working hours, attitude and cooperation to establish the judgement matrix. Then according to AHP, compared the importance of each indicators in each level and expressed the relative importance in numerical form. Used b_{ij} to represent the relative importance of the i-th index to the j-th index. Then the $i*j$ order judgment matrix B was available.

To ensure the conclusion obtained by AHP was reasonable, the second step was to normalize and judge the judgment matrix B to limit the deviation of judgment matrix obtained in the first step in a certain range. If the consistency index was less than 0.1, the judgment matrix consistent was consistent with the requirements, therefore, the weight judgment was basically reasonable.

Then calculated the weight, which is the component vector V_i of the feature vector V.

$$\begin{aligned} V_1 &= (b_{11} \times b_{12} \times b_{13})^{1/3} \\ V_2 &= (b_{21} \times b_{22} \times b_{23})^{1/3} \\ V_3 &= (b_{31} \times b_{32} \times b_{33})^{1/3} \end{aligned} \quad (5)$$

The second step was to determine the evaluation index set.

Set $B = \{working\ hours, attitude, coorperation\} = \{B_1, B_2, B_3\}$. Assigned the corresponding weight vector $W = \{V_1, V_2, V_3\}$ to each factor. The evaluation set $P = \{none, low, relatively\ low, medium, relatively\ high, high\}$. Assigned the value to the elements in set P: $P = \{0, 0.1, 0.3, 0.5, 0.7, 0.9\}$, which indicated the correspondence between the elements of the evaluation set and the contribution coefficient.

The third step was using expert evaluation method to determine the factor evaluation matrix H. The evaluation team evaluated various factors in the factor set B referring to evaluation set P. Evaluated the level of each factors according to the relationship of three factors. Then counted all the results and converted the evaluation results into figure in internal $[0,1]$. So we got the fuzzy vector of factors. Combined those three evaluation results in one matrix, you could get fuzzy relationship matrix H. The score of h_{ij} indicator should meet $\sum_{i=1}^{6} h_{ij} = 1$. After the scoring, averaged the score for each indicator under the comment and got the final score, which was used as the corresponding membership.

$$H = \begin{bmatrix} h_{11}h_{12}\cdots h_{16} \\ h_{21}h_{22}\cdots h_{26} \\ h_{31}h_{32}\cdots h_{36} \end{bmatrix} \quad (6)$$

The forth step was to calculate contribution coefficient and established value sharing matrix:

$$C = W \times H = (V_1, V_2, V_3)\begin{bmatrix} h_{11}h_{12}\cdots h_{16} \\ h_{21}h_{22}\cdots h_{26} \\ h_{31}h_{32}\cdots h_{36} \end{bmatrix} = [c_1, c_2, c_3, c_4, c_5, c_6] \quad (7)$$

The sum of the components in C should be 1. If this condition was not met, it is necessary to normalize C and get the matrix $C^{'}=\left[c_1^{'},c_2^{'},c_3^{'},c_4^{'},c_5^{'},c_6^{'}\right]$, and got the contribution coefficient:

$$E_i = C^{'} \times X^T \tag{8}$$

Then the resource coefficient and risk factor were available through the same way. The influencing factor of resource coefficient mainly included capital investment, financing cost, technical cost, time cost equipment cost, manpower cost and site cost. The main indicators affecting risk factors included technical level, external environmental impact and smoothness of cooperation.

Finally, used E_i, I_i, F_i and formula (4-4) to determine the value sharing ratio for each entity in the energy service industry network and the corresponding sharing value could be obtained: $w_i = Uk_i$.

5. Sample Analysis

To illustrate that the model was correct, this paper took an energy service project for example which was a cooperation between a large industrial enterprise and an energy service company. The total investment was 800 thousand yuan. The electricity cost was 1.8 million yuan before the project. Because of reduced energy consumption, the annual power consumption was less than 1.7 million KWh after the project. This project helped save about one million KWh and the corresponding saving cost was 700 thousand yuan, that was, the value could be shared by the industrial enterprise and the energy service company.

Set the distribution factors for two subjects to be k_1 and k_2. First, determine the risk factors for energy consumption enterprises and energy service companies. According to expert evaluation, AHP judgment matrix is:

$$B=\begin{bmatrix} 1 & 1/5 & 1/3 \\ 5 & 1 & 3 \\ 3 & 1/3 & 1 \end{bmatrix}$$

The weights are $V_1 = 0.11$, $V_2 = 0.62$, $V_3 = 0.27$. The consistency index is $C.R. = 0.068 \le 1$, which satisfy the consistency condition. The influence weights of three factors to energy service companies and corporate risk factors are 0.11, 0.62 and 0.27. These three factors are external environmental impact, technical level and smoothness of cooperation.

Formula (4-6) can be used to calculate the risk factors. The first one is risk factor of the corporation. An assessment team was formed by six experts and score the factor set B. Then the evaluation matrix H was established. Using reference evaluation set P from assessment team to evaluate the factors in set B would get fuzzy relation matrix:

$$H_1=\begin{bmatrix} 0.2 & 0.3 & 0.1 & 0.1 & 0.3 & 0 \\ 0 & 0.4 & 0.2 & 0 & 0.3 & 0.1 \\ 0 & 0.2 & 0.2 & 0.5 & 0.3 & 0 \end{bmatrix}$$

Then used fuzzy comprehensive evaluation method to calculate, $C_1 = V \times H_1 = \left[0.22, 0.335, 0.189, 0.146, 0.3, 0.062\right]$, for those didn't satisfy the condition that the sum of the components was 1, normalized processing was necessary:

$$C_1^{'} = \left[0.176, 0.268, 0.151, 0.117, 0.240, 0.05\right]$$

According to formula (4-5) and (4-8), the risk factor of this industrial enterprise was available:

$$\begin{aligned} F1 &= C_1^{'} \cdot W^T \\ &= \left[0.176, 0.268, 0.151, 0.117, 0.240, 0.05\right] \cdot \left[0, 0.1, 0.3, 0.5, 0.7, 0.9\right]^T \\ &= 0.344 \end{aligned}$$

Similarly, the risk factor of energy service company was $F_2 = 0.656$. The resource input coefficient industrial of enterprises was $I_1 = 0.446$, effort or contribution coefficient was $E_1 = 0.583$; The resource input coefficient of energy service companies was $I_2 = 0.554$, effort or contribution coefficient was $E_2 = 0.417$.

Based on formula (4-3) and (4-4), the value sharing proportion and actual benefit sharing of both energy service company and industrial enterprises are available.

According to the calculation, the value sharing proportion of energy service company was $k_1 = 37.116\%$, and proportion of industrial enterprises was $k_2 = 62.884\%$; the sharing benefits were $w_1 = 259.8$ thousand yuan, $w_2 = 440.2$ thousand yuan.

6. Conclusion

It can be seen that during the contract period after completing the project, this energy service company can get 62.884% energy saving income each year and the industrial enterprises can get 37.116% energy saving income each year. The allocation proportion is technically equitable because compared to the investment and devotion from energy service company, the consumption companies get the long-term service and advanced energy saving systems which can reduce energy consumption with rare investment.

References

[1] Zhu Xuefei. Analysis on Financial Management of Value Chain in Energy - saving Service Company [D]. Shihezi University, 2016.

[2] Zhao Dan. Study on Economic Benefit Evaluation and Sharing Mechanism of ESCo Energy Saving Project. [D]. North Chian Electric Power University (He Bei), 2008.

[3] Liu Na. Research on EMC Cooperation Relationship Based on Creating Sharing Value Theory [D]. Beijing Instituteof Technology, 2016.

[4] Huang Zhixing. Decision-making Research on EPC Project of Energy-saving Benefit Sharing Model [D]. Beijing Jiaotong University, 2016.

[5] Burrows G, Black C. Profit sharing in Australian Big 6 accounting firms: An exploratory study [J]. Accounting Organizations & Society, 2004, 23 (5-6):517-530.

[6] Canes M E, France N. The peculiar economics of federal energy management [J]. Energy Policy, 2016, 91:268-272.

[7] Chauhan S S, Proth J M. Analysis of a supply chain partnership with revenue sharing [J]. International Journal of Production Economics, 2005, 97 (1):44-51.

[8] Chen Jian. Research on the Dynamic Mechanism of Energy - saving Service Enterprises Based on Value Chain Theory [D]. Tianjin University, 2015.

[9] Zhang Xiangyang, Yang Mincai, Liu Huaming. Research on Risk Sharing and Benefit Distribution Mechanism in the Management of Supply Chain [J]. Journal of Huazhong University of Science and Technology (Social Science Edition), 2004, 18 (5):94-97.

[10] Huang Zhixing. Energy saving benefit sharing contract energy management projects of the [D]. investment decision of Beijing Jiaotong University, 2016.