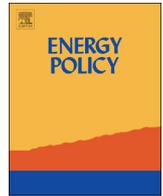




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Research on the energy-saving and revenue sharing strategy of ESCOs under the uncertainty of the value of Energy Performance Contracting Projects



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HIGHLIGHTS

- We provide a method for determining the revenue-sharing bargaining strategy space in a finite bargaining game of the ESCO.
- The increase of the probability of adverse circumstances will increase the revenue share (of the EU).
- We design a forecast–commitment contract between an ESCO and an EU.
- The forecast–commitment contract can eliminate the impact of the uncertain energy savings on the contract execution to a certain extent.
- When the EU takes a greater commitment risk, the ESCO is willing to provide a higher commitment.

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ABSTRACT

Under the uncertainty of the value of Energy Performance Contracting Projects (EPCs), this paper develops a revenue-sharing bargaining model between an Energy Service Company (ESCO) and an Energy-Using Organization (EU). Based on the model the paper analyzes the impacts of energy prices, risk-adjusted discount rates and accidents on the ESCO's bargaining strategies. The research shows that the greater the probability of adverse circumstances is, the higher is the revenue share (of the EU), and the more disadvantageous is the ESCO's position in the game. Furthermore, we design a forecast–commitment contract between an ESCO and an EU and analyze the optimal product's energy savings commitment strategy of the ESCO to cope with uncertain energy savings and contract risk. The research illustrates that by introducing penalties and commitments, the contract can eliminate the impact of the uncertain energy savings on the contract execution to a certain extent; when the EU takes a greater commitment risk, the ESCO is willing to provide a higher commitment, thus enhancing the strategy value of the bilateral relationship and reducing the contract risk. Finally, the policy recommendations about improving shared savings contract standard, third-party energy savings measurement and verification mechanism and arbitration mechanism of EPCs are provided.

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1. Introduction

Although many energy conservation and emission reduction policies have been unveiled since “the 11th Five-Year Plan” in China, these administrative energy conservation measures gradually lose their effect. The Energy Performance Contracting (EPC), a market-oriented mechanism for promoting energy efficiency, has been increasingly welcomed by governments and enterprises. The use of

the EPC in China began with the Energy Performance Contracting Project, a collaboration between China's government and the World Bank in 1998. According to “The Development Report of China's ESCOs” in ‘the 11th Five-Year Plan’, the total output value of ESCOs in China increased from 4.73 billion Yuan in 2005 to 83.629 billion Yuan in 2010. There were 782 ESCOs in 2010, whereas there were only 3 in 1998. The report predicted that there would be 2500 ESCOs and the output value would be 300 billion Yuan by 2015.

The EPC has become the most important mode for developing the energy service industry. It was developed after the oil crisis in North America in the 1970s. The EPC refers to a service mechanism for energy conservation. The ESCO signs an energy-savings project contract with an EU, and provides the necessary service according

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to the energy savings target. The EU pays part of the energy-savings revenue regularly to cover the investment and reasonable profit (SAO, 2011). During the contract period the ESCO owns the project but transfers the project ownership to the EU at the end of the contract period. Currently, the mainstream structures of the energy service contract are the shared savings structure and the guaranteed savings structure. The EU is required to take part of financing risk in a guaranteed savings contract, whereas the ESCO is responsible for project financing under a shared savings contract. Shared savings contracts are more suitable in developing countries, where energy conservation projects lack a reliable and commercially viable means of financing, and the industrial EUs with high energy intensity always pursue short-term economic benefits and are reluctant to invest in energy saving project (Bertoldi et al., 2006; Lin et al., 2004). Shared savings contracts are widely used throughout China, in addition to the reason that EUs' weaker willingness to invest in energy conservation, the government support to shared savings contracting is also important impetus. In order to support the rapid development of the ESCOs, the government have introduced support policies to spread shared savings contracts (because this can make ESCOs enjoy more preferential policies than EUs). Both the tax cuts policy released in 2010 and financial incentives policy released in 2011 are clearly required only shared savings contracting can enjoy them¹; there are no similar policies to support guaranteed savings contracting in China. The shared savings contract process is shown in Fig. 1.

Implementation of the shared savings contract is influenced by numerous types of risks; therefore, the negotiation of risk and revenue sharing clauses is necessary for the successful operation of the project (Chan and Yu, 2005; Xu et al., 2011). Empirical research has found that the amount of energy savings is highly uncertain (e.g., the energy savings in this paper). Goldman et al. (2002) conducted a market performance survey of 63 ESCOs in the U.S. between 1992 and 2002 and found that there are three types of energy savings in the negotiation to implementation stages of an EPCP (Energy Performance Contracting Project): predicted, guaranteed and actual energy savings (the guaranteed energy savings are not greater than the predicted energy savings). Among all the survey responses, 369 different energy-saving projects reported their predicted and actual energy savings. The actual energy savings was greater than the predicted energy savings in 57% of the projects. The actual energy savings was less than the predicted in 30% of the projects. In only 13% of the projects was the actual energy savings equal to the predicted, and the actual energy savings deviated from the predicted by 15% or more in 40% of the projects. The uncertainty in these projects' overall energy savings leads directly to the uncertainty of energy savings in a single phase. Furthermore, because of business risks (especially sluggish sales and excess inventory in industrial enterprises), the product yield in a single phase is also uncertain, which will also result in the uncertainty of energy savings in a single phase. Bannai et al. (2007) studied the ESCOs in Japan. They note that the energy service contract period is typically limited to 10 years because of the long payback period. Longer-term contracts are subject to fluctuations in energy prices and energy-saving equipment utilization risk. Ansar and Sparks (2009) indicated that energy-saving projects may be affected by unexpected events, such as bankruptcy and dramatic climate changes. In addition, the EPCPs face contract risk (EVO, 2009) when the participants do not fulfill the contract obligations, resulting in renegotiation, breach of

contract or early termination of the contract. In China's current situation, the energy services industry is in a fledging period, the measurement and verification (M&V) of energy savings are not standardized, and a lack of integrity problem is very serious. In this context, the ESCOs take a great financial risk² under a shared savings contract. Lin Boqiang, the director of China's Energy Economic Research Center, remarks that "the EPC financing and M&V of energy savings problems urgently needs to be resolved, and the integrities of ESCOs and EUs need to improve³."

By referring to the standard contract of the EPC (SAO, 2011) and the real shared savings contract for cogeneration of the Guangzhou Zhiguang Energy Service Co., Ltd., we sum up the main variables in shared savings contracts, which include: the contract period, the revenue-sharing ratio in the contract period, energy prices, the ESCO's commitment to the product's energy savings, the EU's commitment to the product yield in a single phase, and the compensation of the ESCO and EU for not reaching the commitments. It is apparent that although there are certain measures of risk identification and mitigation in the real contracts, it is difficult to provide an answer as to how to choose negotiating strategies. Therefore, the goals of this research are to model the shared savings contract and its negotiation process, to quantitatively analyze the impacts of energy prices, accidents, energy savings and contract risks on the ESCO's revenue sharing strategies, and to optimize the strategies.

Bargaining theory, an important branch of non-cooperative game theories (Rubinstein, 1982), is widely used in Build-Operate-Transfer, Public-Private-Partnership project negotiations and other related areas to determine the equilibrium concession term. An EPCP negotiation is a typical non-cooperative game and bargaining theory is applicable for its analysis. However, few studies have utilized bargaining theory to analyze an EPCP negotiation. Zhang and Liu (2009) discussed the energy service purchase decisions of a building owner and the information disclosure decisions of an ESCO based on an asymmetric evolutionary game model; Zhang and Liu (2011) analyzed the pricing mechanism of the building energy efficiency services from the building owner's viewpoint based on principal-agent theory; by using two-period extensive game theory, Huang and Li (2011) studied the financing problem of small and medium sized ESCOs; Kutlu and Polat (2011) established an energy service outsourcing decision model by real options approach integrated with the transaction cost economics approach. Their findings are important, but they do not address EPCP negotiation. Zhang et al. (2008) established a decision-making model of the ESCO's project operation period based on the game theory, but the revenue share was given. An EPCP is conducted over a long period of time and the project value faces a random and unstable environment; thus, not all of the uncertainties can be modeled by the Rubinstein model, which assumes that the bargaining environment is stable and certain (Muthoo, 1999). In accordance with the real contract variables, we divide an ESCO's revenue sharing strategies into two parts; the first is the bargaining strategy of the contract period and the revenue share in that period (e.g., the ESCO chooses to offer that the contract period is 10 years and the ESCO shares 80% and the EU shares 20% of annual energy-savings revenue), and the second is the commitment strategy of the product's energy savings

¹ Ministry of Finance and State Administration of Taxation released the Notice "Value-Added Tax, Business Tax and Corporate Income Tax Policy Issues on the Promotion of Energy Services Industry" in December 2010, see http://www.gov.cn/zwqk/2011-02/17/content_1804866.htm; National Development and Reform Commission and Ministry of Finance issued the Notice "Financial Incentives to Energy-Saving Technological Transformation" in July 2011, see http://www.gov.cn/zwqk/2011-06/24/content_1891712.htm.

² In 2010, Beijing Hua Tong Xing Yuan Heating Energy Technology Co., Ltd. sued HuaQing Property Company because the latter partially rejected to pay the energy-saving earnings. The former finally won the lawsuit after expending lots of time and money. The key of the case was the recognition of the EU's energy savings. The case showed that energy savings-related clauses are so important in the backdrop of imperfect industrial norms.

³ O. C., M., 2012. The "blowout" of EPC, third party audit firms need to be expanded [N]. Oriental Morning Post, 10-10A34.

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