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Energy Service Companies (ESCOs) in China: Barriers and drivers from ESCOs' perspective

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AALTO UNIVERSITY SCHOOL OF ECONOMICS ABSTRACT
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ABSTRACT

Objectives of the Study

China as the world's largest energy consumer and greenhouse gases emitter has a great urgency to improve its energy efficiency. Chinese Central government has made ambitious targets to reduce energy and carbon intensity in the 12th five-year plan (2011-2015). It also leverages the important role of Energy Service Companies (ESCO) using Energy Performance Contracting (EPC) in achieving these targets. Despite the huge potential and favoring policies, ESCO's diffusion in China is far from reaching its potential and large amount of cost-effective investment opportunities are unexploited. Therefore, the objective of this research is to offer an understanding of the underlying economics of ESCO market in China, and to contribute to the knowledge about the drivers and barriers in China for ESCOs.

Academic background and methodology

The theoretical framework guiding this study was the Transaction Cost Economics (TCE). It is said, that the slow diffusion rates of ESCO market can be understood in terms of transaction costs. While Oliver Williamson developed the original theory, this study used the determinants of production and transaction costs modeled by Sorrell to identify the important barriers and drivers to ESCOs in China. Extensive literature review was done to understand the development of Chinese ESCO industry and semi-structured interviews were conducted for the empirical research.

Findings and conclusions

In the current market's elements, most ESCOs are SMEs; projects concentrating in industry sector using mainly Shared Saving Model and the industry's investments and energy savings far from potentials. Variables as ESCO's and customer's size, relation between ESCO and customer were suggested to complete Sorrell's explanatory model for energy service contracting. More valuably, Chinese ESCOs perceptions were classified into the market, institutional, financial and technological barriers and drivers. Most important perceived barriers were intense competition for customers and technical experts, uncertainty in market dynamics with abrupt M&As, complexity in project and reward approval, difficulties in financing and lack of domestic technology. Most important perceived drivers were demonstrative effect of successful projects, standardized contract model, financing resource through capital market and cooperation with experts from education and research institutions.

Keywords

Energy efficiency, Energy Service Company, ESCO in China, Transaction Cost Economics

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ABSTRAKTI

Tutkimuksen tavoitteet

Kiina, maailman suurimpana energian kuluttajana ja hiilipäästöjen tuottajana, on isojen ympäristöhaasteiden edessä. Kiinan valtio onkin asettanut kunnianhimoiset tavoitteet energiaintensiteetin ja hiilidioksidi-intensiteetin alentamiselle 12. viisivuotissuunnitelmassa. ESCO-konsepti on nostettu valtiontasolla keskeiseksi keinoksi energiakäytön tehostamiseen. Suuresta markkinatarpeesta ja myönteisestä politiikasta huolimatta, ESCOn leviäminen Kiinassa kaukana sen potentiaalistaan. Tämän Pro Gradu-tutkielman tarkoitus on antaa ymmärrystä ESCO-toimialan kehitystä sen alkuvaiheista nykyhetkeen ja selvittää ESCOa edistävät ja estävät tekijät.

Kirjallisuuskatsaus ja metodologia

Transaktiokustannusteoria toimii keskeisenä teoreettisena viitekehyksenä tässä Pro Gradu-tutkielmassa. David Sorrell (2005) on kehittänyt kyseisen teorian pohjalta oman viitekehyksen energiapalveluiden sopimiseen. Hänen mallinmukaisia tuotannon- ja transaktionkulutekijöitä käytettiin kiinalaisten ESCO-yritysten edistävien ja estävien tekijöiden tunnistamiseen. Kiinan ESCO-toimialan nykytilan ymmärtämistä varten tehtiin laaja-alainen kirjallisuuskatsaus ja semi-strukturoiduilla haastatteluilla kartoitettiin toimialaa edistäviä ja estäviä tekijöitä.

Tulokset ja päätelmät

Kiinan nykyisissä markkinaelementeissä suurin osa ESCOista on PK-yrityksiä, projektit keskittyvät teollisuuteen ja niissä käytetään pääasiallisesti Shared Savings-mallia. Toimialan investoinnit ja energiansäästöt ovat kuitenkin kaukana potentiaalistaan. ESCOn ja asiakkaan koko sekä ESCO:n ja asiakkaan väliset suhteet ovat ehdotettuja muuttujia täydentämään Sorrellin mallia energiapalveluiden sopimiseen. Tutkielman arvokkaimmat tulokset ovat kiinalaisten ESCO-yritysten näkemykset estävistä ja edistävistä tekijöistä. Kova kilpailu asiakkaista ja teknisistä osaajista, äkillisistä yrityskaupoista johtuva epävarmuus markkinadynamiikassa, projektien ja tukien hyväksymisprosessien monimutkaisuus, rahoitukselliset vaikeudet ja kotimaisen teknologian puute ovat tärkeimpiä havaittuja esteitä. Onnistuneiden projektien mainosvoima, standardoitu sopimusmalli, rahoituksen järjestäminen pääomamarkkinoilta ja yhteistyö koulutus- ja tutkimusinstituutioiden asiantuntijoiden kanssa ovat taas tärkeimpiä havaittuja kannustimia.

Avainsanat

Energiatehokkuus, Energiapalveluyritys, ESCO Kiinassa, Transaktiokustannusteoria

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ABBREVIATIONS AND ACRONYMS

EE	Energy Efficiency
EMC	Energy Management Contracting
EMCA	ESCO Committee of China Energy Conservation Association
EMCo	Energy Management Company
EPC	Energy Performance Contracting
ESCO	Energy Service Company
FI	Financial institution
GEF	Global Environment Facility
GHGs	Greenhouse gases
IFC	International Finance Center
MOF	Ministry of Finance
NAESCO	National Association of Energy Service Company of the United States
NDRC	National Development and Reform Committee
SME	Small and Medium Enterprise
SOE	State-owned Enterprise
Tce	Ton of coal equivalent
TCE	Transaction Cost Economics
WB	World Bank

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1 INTRODUCTION

1.1 Background

The ever-increasing energy consumption has resulted in dramatic changes of the environment constituting a threat to our society. Caused by the greenhouse effect, global warming has gained great attention worldwide. Greenhouse gas (GHG) emissions are from the high consumption of non-renewable fossil energy sources as coal, oil, and natural gas. Countries around the world have attached great important to energy conservation and energy efficiency. From the perspective of business world, energy cost accounts for a sizeable proportion of the total operation cost, especially in energy intensive industries. Exploring the ways to improve energy efficiency and reduce energy costs has risen to be one of the main subjects for the business world.

Comparing to the developed countries, China's energy issues are more serious. China's energy intensity (energy consumption per unit of GDP) is 2.65 times of the world's average, 3.9 times higher than the United States, 4.32 times higher than the European Union and over 8 times of Japan. China consumes 36% of world's total steel consumption, 16% of energy consumption and 52% of cement consumption, but only creating 7% of global total GDP (EIA, 2012). Therefore, the country has an urgent need to improve its energy efficiencies.

China is the largest consumer and a net importer of energy. As the dependence on energy imports increases, the concern of energy security draws the strategic importance of energy efficiency (EE) in China. At the same time, as the world's largest Greenhouse Gases emitter (80% from burning coals (Dresseen, 2011)), China also suffers from serious environmental-pollution problems related to energy. According to China's environmental analysis report released in 2013, seven of the world's ten most polluted cities are located in China. By the term of conducting this study, Beijing's air quality was recorded as 30 times over international safety levels (January 2013). The environmental pressures again address the importance of energy efficiency. As the result, Chinese government has put high emphasis on this issue.

Chinese government had a goal to reduce energy intensity for 20 percent in its 11th five-year plan (2006-2010). In its recent 12th five-year plan, China has targeted to further reduce energy intensity by 17.3 per cent by 2015 and 31 per cent by 2020 from 2010 levels, and even more ambitiously a 40-45 per cent carbon intensity reduction in future ten years from 2010 levels. Energy Service Companies (ESCOs) have become a national policy priority for government and play an important role in achieving these targets (Dresseen 2011).

Energy Service Company (ESCO) concept using Energy performance contracting (EPC) mechanism was developed in North America in the 1970s after the oil crises. Chinese government together with World Bank (WB) and the Global Environmental Facility (GEF) introduced this market-oriented mechanism for energy efficiency in China in 1998. It is expected that ESCOs will play an important role in promoting energy efficiency in countries outside of the US (Vine et al. 2003).

1.2 Research objective

The energy efficiency and ESCO market potential in China is huge due to the numerous large-scale, inefficient energy-intensive industrial companies. A general estimation of the investment opportunity by International Finance Corporation (2011) excessed 100 billion US dollars. The saving potentials estimated by the current energy consumption level were up to 40% (Zhang et al., 2008). Due to the strategic importance of EE, national policies are also favouring ESCOs (IFC 2011).

Despite the huge potential and favouring policies, there are strong opinions from researchers that ESCO's diffusion in China is far from reaching its potential and large amount of cost-effective investment opportunities are unexploited (Gan 2009, Li & Colombier 2009, Limaye & Limaye 2011, Li 2012, Kostka & 2013). The phenomenon that economically profitable energy efficiency investments are not being realized is called "energy-efficiency paradox" (Zhang 2003). It is also known as "energy efficiency gap" expressing the difference between the potential cost-effective energy efficiency investments and the actual investment level implemented (Brown, 2001; Levine et al., 1995; Golove and Eto, 1996; Jaffe and Stavins, 1994; Sanstad and Howarth, 1994. Cited in Goldman et al., 2005). Why is this the case? The existence of "energy efficiency paradox" or "energy efficiency gap" is discussed in terms of market failures and market barriers (Jaffe and Stavins, 1994; Goldman et al., 2005; Rohdin et al., 2007). Goldman et al. continued stating that the slow diffusion rates of ESCO market can be better understood in terms of the transaction costs rather than the types of neo-classical market failures.

Under this big picture, the objective of this research is to offer a general understanding of the underlying economics of ESCO market in China, and to contribute to the knowledge about the drivers and barriers in China's ESCO industry by identifying and analysing the existing and perceived drivers and barriers from ESCOs' perspective.

To address the purpose of the research, this study aim to answer the following research questions from supporting questions to the main question:

Supplementary research questions:

1. What is the state of ESCO in China?

2. What are the identified drivers and barriers for both ESCOs and its potential customers in China?

Primary research question:

3. Under Sorrell's transaction cost economics (TCE) framework, justify the effects of the production and transaction cost determinants in resulting of viable ESCO project. How Chinese ESCOs have perceived the previously identified drivers and barriers under the TCE framework?

1.3 Methodologies

The core theoretical framework guiding this study is the transaction costs economics (TCE) (See Chapter 4). According to Sorrell (2007), the total savings in production costs must be greater than the transaction costs in order to have an economically viable energy service contracting. For the first research question, extensive literature will be reviewed for the description of ESCO development from its introduction to present. To answer the research question two, drivers for and barriers to the supply and demand sides will be identified from industrial and governmental sources. The empirical research will be conducted by interviewing Chinese ESCOs. Details of empirical research design and process are described in Chapter 5. With semi-structured interviews, we hope to gain valuable answers to the third research question as finding the important drivers and barriers under the determinants of transaction costs. Additionally, supplementary interviews with national ESCO association and local energy conservation centre will be conducted to support this study.

1.4 Disposition of the thesis

This paper is divided into seven chapters. Introduction chapter presents the background for this study, the objective and research questions, the research methodologies used to answer the research questions and outline of the paper. Second chapter provides solid understanding base of ESCO-concept, what it is, how it works and to whom it targets. The third chapter concentrates on describing the development and current state of China's ESCO market and the identified drivers for and barriers to ESCO development through extensive literature reviews. Transaction Cost Economics as the theoretical framework for the empirical research is introduced in chapter four with the focus on Sorrell's model. In chapter five, the design and process of the empirical research is presented and followed by result presentation in chapter six. The last chapter concludes this study and discusses the limitations and future research objectives.

2 THE CONCEPT OF ESCO

In this chapter, we will present the definitions of what ESCO is, how it works and who the customers are. This chapter will offer the audiences a general understanding of the conceptual backgrounds.

2.1 Definition of ESCO and Energy Performance Contracting (EPC)

Energy Service Company (ESCO) is a relatively fresh concept, firstly developed in North America in the 1970s and the introduced to China in 1998. For many of us, ESCO remains still unaware; therefore this subchapter aims at clarifying the concept of ESCO.

So what is ESCO? National Association of Energy Service Company of the United States (NAESCO) defines ESCO as “a business that develops, installs, and arranges financing for projects designed to improve the energy efficiency and maintenance costs for facilities over a seven to twenty year time period”. In the “General Technical Rules for Energy Performance Contracting (GB/T 24915-2010)” issued by China’s National Standardization Management Committee in 2010, it has a more loose definition including any professional company, that offers energy audit, energy-saving project design, financing, renovation (construction, equipment installation, setting), operation and management services as an energy service company. China also uses the term “Energy Management Company (EMC or EMCo)” equally to ESCO. To avoid any confuses for the audience, this study will concentrate on using the abbreviation “ESCO” referring both.

Under these definitions, what are the differences between ESCO and other companies in the energy-saving consulting or in the energy-saving equipment manufacturing business? Bertoldi et al. (2005) stated that ESCO differs from others as it guarantees the energy savings, it finances or assists in financing. ESCO’s remuneration is based on the energy-savings achieved. Fundamentally, ESCO is undertaking the technical and performance risks from customer by using the Energy Performance Contracting (EPC) concept. Again, China uses here the term

“Energy Management Contracting (EMC)” equally to EPC. This study will use the abbreviation “EPC” referring both.

What is Energy Performance Contracting? In the EU’s Energy Service Directive (2006/32/EC), the energy performance contract is defined as: “a contractual arrangement between the customer and ESCO of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement.” In China’s general technical rules, EPC is an energy efficiency service mechanism, where the energy service company and the energy end-user make a contractual agreement on the energy-saving targets of the energy efficiency project. The energy service company provides the services to achieve the energy-saving targets and the energy end-user pays the energy service company’s investment with a reasonable profit according to the energy savings.

The basic EPC concept illustrated by the World Bank (See Figure 1) further clarifies that ESCO offers a comprehensive range of energy efficiency related services through a guaranteed EPC contract to the customers.

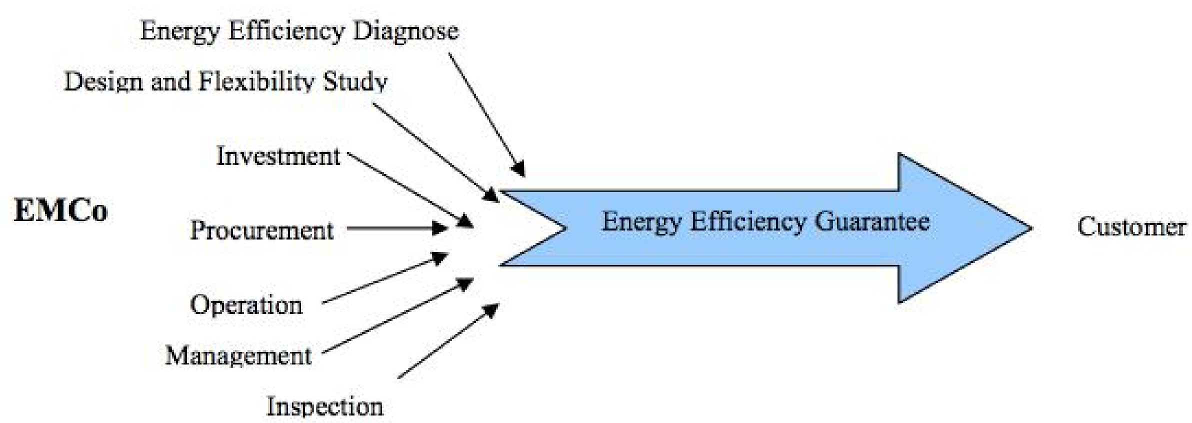


Figure 1 EPC basic concept (World Bank, 2007)

The EPC gives customers the opportunity to upgrade their processes and equipment initially without own investments. From these definitions, we can see that the remuneration of ESCO in EPC is directly based on the energy-saving amount. If the energy efficiency improvements are not achieved, the ESCO doesn’t get paid. For comparison, the non-EPC arrangement is traditionally based on a fixed fee-for-service contract with no direct linkage to the result of energy services. In most ESCO projects, after the end of contract, the energy-saving value is passed on to the customer. Figure 2 further illustrates the ESCO's profit model.

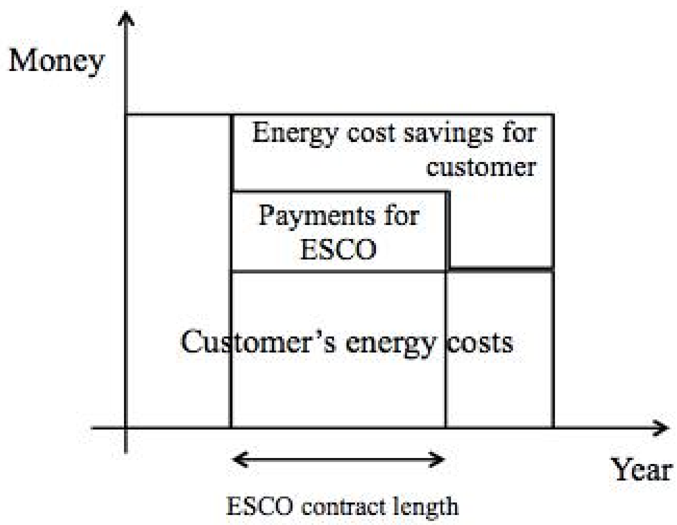


Figure 2 ESCO's remuneration model

2.2 Characteristics of ESCO

The ESCO-concept has some specific characteristics. Hereby the most significant ones are listed.

Commerciality: Energy service is a commercial operation. The energy performance contracting mechanism is implemented in energy service projects to achieve the purpose of profit for ESCO.

Adaptability: ESCO has a modular approach incorporating different kinds of services to meet customer's needs. It can adapt the scope of services including necessary components into the energy service package. (Bleyl-Androschin, 2009) ESCO is not about promoting any particular energy efficiency equipment or technology. By energy performance contracting, ESCO provides an integrated comprehensive "turnkey" energy-saving solution. ESCO is not a financial institution, but it can assist the customer to get the project funding. ESCO is not necessarily energy-saving technology owner or equipment manufacturer, but it has the ability to choose the suitable technology and equipment for the customer. ESCO may not necessarily have in-house engineering capability to implement the project, but it can give guarantee promise of project implementation.

Riskiness: The ESCO bears the most of technical and performance risks and sometimes even the financial risks under the EPC. The invested equipment are usually specifically designed for project's processes and systems, therefore they have a limited resale value. The long duration of the projects makes it vulnerable for external and internal changes. ESCO business is a high-risk business and the key to success lies on the ability of risk management.

2.3 ESCO project elements

As stated in the previous paragraph, one of ESCO's characteristics is the modular approach. ESCO generally provides its customer a comprehensive package of energy services. The service scope includes all or some of the following elements (See Figure 3):

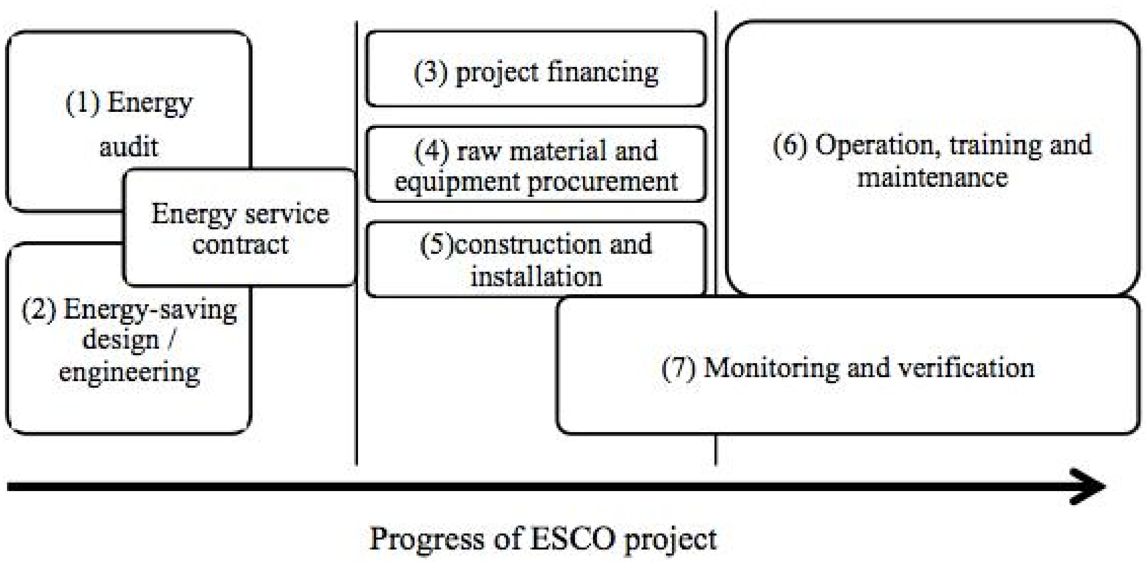


Figure 3 ESCO project elements

(1) Energy audit. ESCO determines customer's energy usage profile and energy demand structure to propose the energy-saving potential. It also performs evaluation of energy conservation measures.

(2) Energy-saving design/engineering. According to the results of energy audit, ESCO proposes the energy service solution to improve energy efficiency and reduce energy costs. ESCO usually provides both engineering calculation and financial pro-forma to illustrate the project's benefits. ESCO can continue with more detailed implementation design/engineering after customer accepts the energy-saving proposal.

(3) Project financing. Depend on the EPC model used, ESCO may provide from its own capital, assist the customer or acquire itself through third-party financing channels the needed investments for the project.

(4) Raw materials and equipment procurement. ESCO purchases the necessary materials and equipment according to the requirements either from its own production or externally.

(5) Construction and installation. Under the EPC contract, ESCO is responsible for project construction and equipment installation. It is usually done either by ESCO or delegated to qualified construction units.

(6) Operation, training and maintenance. ESCO usually possesses an operational role over the life of the contract. Most projects include the maintenance of all or some of the newly installed equipment over the life of the contract. As an additional service, most ESCOs also provide training for customers' stuff to operate and maintain the equipment. (NAESCO)

(7) Monitoring and validation. Together with customer, ESCO monitors the differences between pre-implementation and post-implementation, and verifies the actual savings through the agreed measurement.

As mentioned earlier, one of the differences between ESCOs and other engineering companies, energy-saving equipment suppliers or technology providers is the energy performance contracting used in ESCO business. Figure 4 further emphasizes that ESCOs have the capability to offer comprehensive energy services, while others have only competences in certain elements.

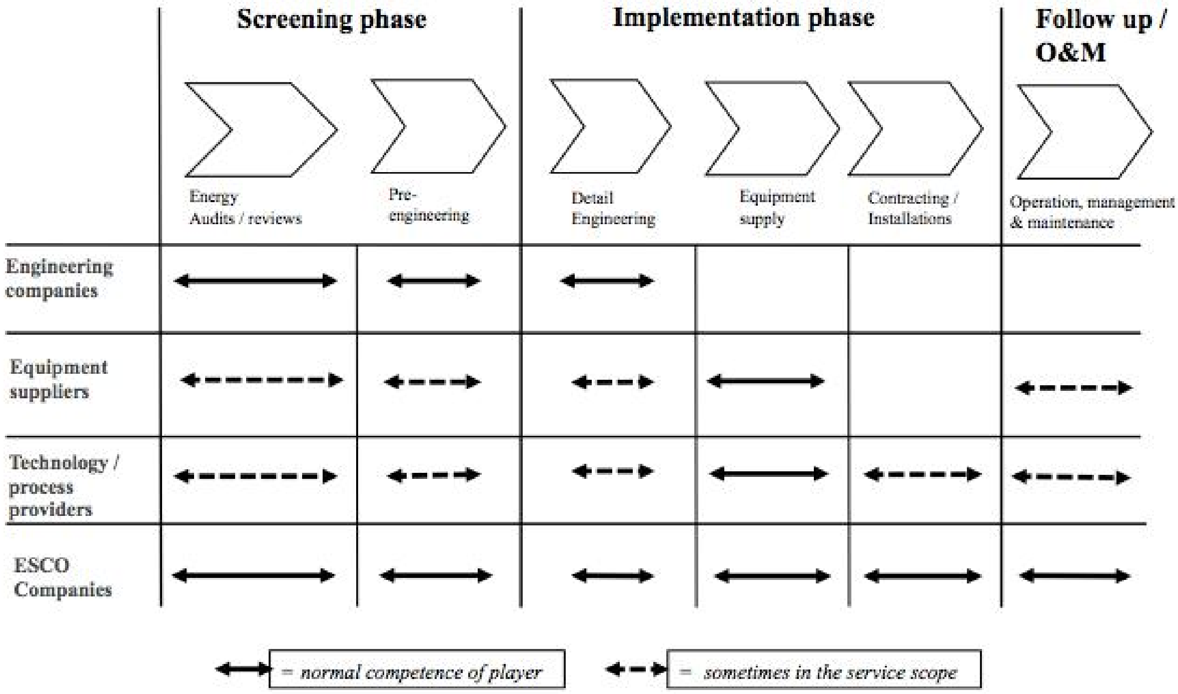


Figure 4 Comparison between ESCOs and other energy service companies (Siitonen, 2012)

2.4 Performance contracting models

Generally agreed by the academic and business world (CTI, 2003; Dreessen 2003; J.P. Painuly et al. 2003; Hansen, 2003; Poole and Stoner, 2003; Bertoldi & Rezessy, 2005; Bertoldi et al., 2006; Taylor et al., 2008), there are two major energy performance contracting models: Guaranteed Savings model and Shared Savings model. Beside these two, there are also other mixed models or sub-variations. This subchapter will mainly focus on introducing the two dominant models.

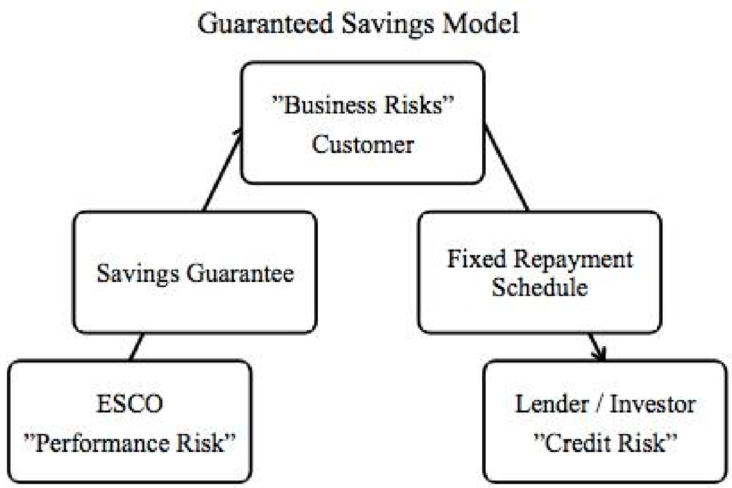


Figure 5 Guaranteed savings model (Dresseen, 2003)

In the guaranteed savings model, customer carries the credit risk by funding the project through its own capital or by signing a loan contract with financial institution. Under this model, the customer is fully responsible for the loan payments. The loan also goes on customer's balance sheet affecting customer's debt ratio. ESCO does not enter into any financial relationships with the financial institution, but may assist the customer in seeking them through its networks. ESCO carries only performance risk by having an EPC with customer. In the contract, the energy saving amount is guaranteed by ESCO.

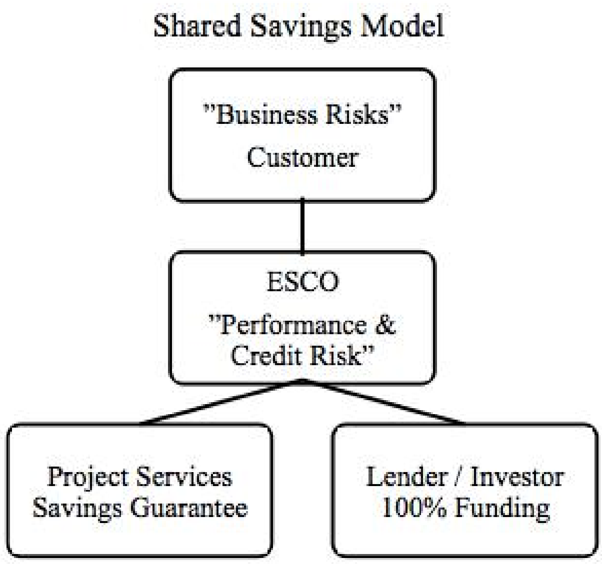


Figure 6 Shared savings model (Dresseen, 2003)

In the shared savings model, ESCO carries both credit and performance risk. ESCO provides an energy performance contact for customer and acts as “financing institution” by securing necessary investment itself or through a loan agreement with third-party financial institution. In this model, customer can benefit from off-balance sheet financing because the debt service is treated as an operational expense (Bertoldi & Resessy, 2005). The payment for ESCO is the reduction in operational expenses, not the debt of investment (CTI, 2003). The performance is linked to the cost of energy saved during and after the project. The customer shares a split of realized energy savings with ESCO for a specified period. Accordingly, there is no standard split percentage, as it is dependence on the various nature of the project (Bertoldi et al. 2006). From the ESCO`s perspective, shared savings model increases the involvement between ESCO and its customer by adding the financial service, which tights up the business relationship. The off-balance financing possibility also increases the attractiveness of contracting. On the downside, it limits long-term growth of small ESCOs, since a small volume of projects saturates ESCO’s balance sheet (Taylor et al. 2008).

It is argued (Lin et al., 2004; Bertoldi et al., 2006) that the lack of reliable and commercially viable long-term financing for energy efficiency projects makes the shared savings model the only possible model for introduction in the developing markets. The guaranteed savings model is not suitable for introduction, since it requires customers to assume credit risks. The guaranteed savings model also required a well-established banking structure, where banking sector are highly aware of energy efficiency projects (Bertoldi et al. 2006). An important difference between guaranteed and shared savings models is that the performance guarantee is the level of energy saved in guaranteed savings model, while it is the cost of energy saved in shared savings model (Hansen 2003, Poole and Stoner 2003).

Table 1 Differences between two models from customers' perspective

Customers' view	**Shared saving-model**	**Guaranteed saving-model**
Credit risk	No	Yes
Payment	Shares % on energy cost savings for a pre-determined period to ESCO	Debt repayment to FI Fee for guaranteed energy-saving level to ESCO
Accounting	Off balance sheet	Debt on balance sheet

A third model called outsourcing energy management model is also used case by case in China, where ESCO manages customer's energy-use systems for a fee (ASTAE 2008). The profit comes from the difference in the energy cost before and after ESCO undertakes energy efficiency renovations with a fee.

2.5 Scope of ESCO customers

Commercial and profit-seeking ESCOs identify and design energy efficiency projects for a variety of customers. The customer range of ESCO generally includes all type of energy end-users with large energy consumption. The categorization can be made according to the next table.

Table 2 ESCO's customer categorization

	Building sector	**Industry sector**	**Traffic sector**
Private	e.g. mall	e.g. paper mill	e.g. automobile power
Public	e.g. school	e.g. district heating company	e.g. public lighting

In the building sector, the ESCO projects are mostly related to the modernization of lighting systems, elevating systems, controlling systems, renovation of air conditioning, heating and ventilation systems et cetera. In the industry, the projects mostly include e.g. equipment retrofits, upgrades, air-pressure and heat recovery system renovation and so on. The customers can be government or municipal institutions, state-owned enterprises, also private-owned buildings and businesses. In the traffic sector, the customers are mainly municipalities that wish to modernize their public-lighting systems (Zhang, 2003).

3 LITERATURE REVIEW OF ESCO DEVELOPMENT IN CHINA

This chapter describes the development of ESCO industry in China from its introduction to present (2013). This chapter also identifies the drivers for and barriers to ESCO development in this specific market through reviewing literature from industrial and governmental sources. Answers to research questions one and two are provided in this chapter.

3.1 Historical performance

ESCO as a market-oriented mechanism for promoting energy efficiency was developed in North America in the late 1970s after the oil crises. The introduction to China was through an international cooperation between China's State Economic and Trade Commission nowadays known as the National Development and Reform Commission (NDRC), the World Bank (WB) and Global Environment Facility (GEF) in 1998. The "China Energy Conservation Project" was divided into two phases. Phase I with GEF grants of 22 million US dollars and International Bank for Reconstruction and Development loan of 63 million US dollars (Sun et al, 2011). The main objective of phase I was to promote EPC mechanism and develop ESCO industry in China. The objective was achieved through demonstration and dissemination. Under the project frame three energy service companies (ESCOs) were established, each from Liaoning Province, Shandong Province and Beijing Municipality. These ESCOs were dedicated to demonstrate the applicability of ESCO business model in China. At the same time, non-profitable Energy Conservation Information Dissemination Center was established to introduce and develop energy performance contracting. (Zhang 2003, WB 1998)

Three piloting ESCOs operated as commercial business, adapting the energy performance contracting to suit the Chinese business environment. In the demonstration phase, these ESCOs used Shared Savings Model. ESCOs financed the projects, undertook the technical risks and owned the equipment installed for customers. The payback was a share of the energy savings achieved, covering the investment, operating costs, risks and a reasonable profit. (WB, 1998)

During the phase I, these three ESCOs have proven to be successful and have grown significantly their ESCO business. On average, Beijing, Liaoning and Shandong ESCOs' assets have grown over 9 times. (WB, 2007) The figure below illustrates the development of these three ESCOs in both net worth and revenue.

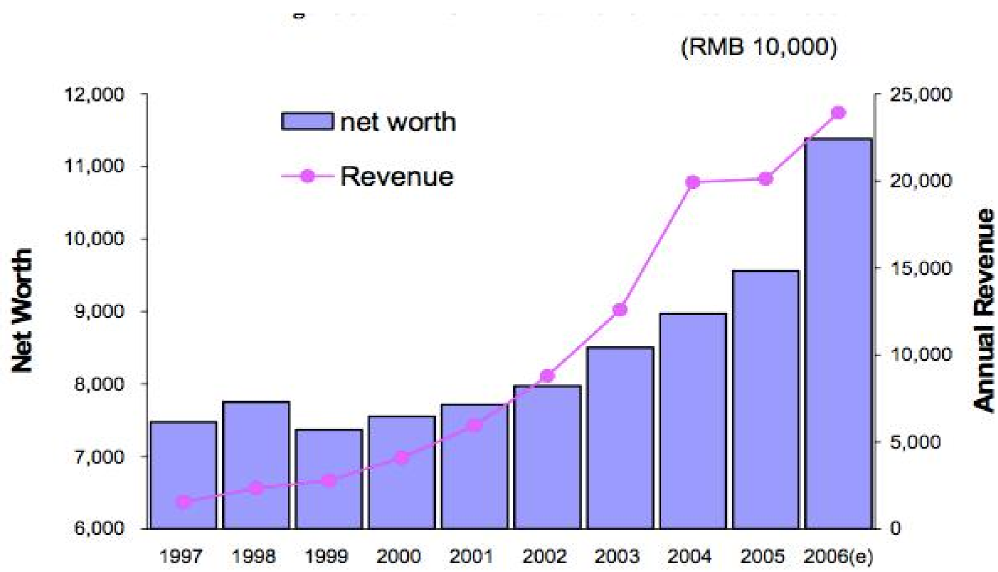


Figure 7 Financial performance of demonstration ESCOS (WB, 2007)

World Bank (2007) reported, that during the energy conservation project from 1998 to 2006, the total energy savings were 5.92 million tons of coal equivalent and carbon dioxide emissions reductions were 5.06 million tons of carbon.

The success of these piloting ESCOs has proved the feasibility of EPC in China and has created positive reactions among new players to enter the ESCO business. Under these market conditions, the Second Energy Conservation Project was approved in 2002 to help new ESCOs to obtain local bank loans through a special loan guarantee program and China's own ESCO industrial association was established (WB, 2007). ESCO Committee of China Energy Conservation Association (EMCA) was registered in 2003. The mission of EMCA was to promote the sustainable development of ESCO industry and to support the fast and healthy growth of ESCO (EMCA).

The energy conservation project has demonstrated the strong market demand for energy performance contracting services across sectors. Next subchapter will look into the current status of ESCO in China.

3.2 Current market situation

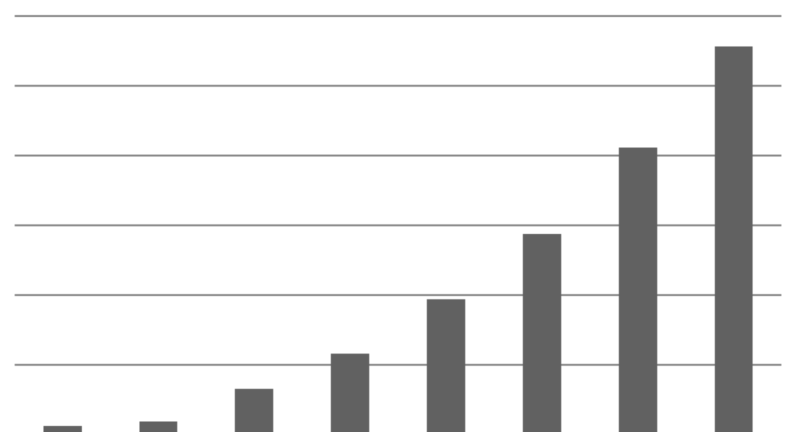
The market information was collected through secondary sources from EMCA's surveys in the end of 11^{th} five-year plan (2010) and 2011. The statistics for 2012 was not yet released during this study. Therefore, it was obtained through primary data collection from EMCA officer. The "ESCO best practices 2012" published by EMCA in January 2013 was also reviewed as reference literature. Despite some skepticism toward Chinese statistical data among international audiences, the following subchapter will present five insights of the trends in China's ESCO industry through the dataset available.

3.2.1 Most ESCOs are SMEs

By the end of 11^{th} five-year plan, the total number of ESCOs using energy performance contracting was 782, which is 8-fold of the amount in 10^{th} five-year plan 2001-2005 (see Table 3). The strong growth continued, almost doubled in 2011 and tripled in 2012. By the end of 2012, the total number of companies in ESCO industry by EMCA sources were 4175, among these 2339 were registered with the Ministry of Finance (MOF) and National Development and Reform Committee (NDRC).

"While there are about 20 very large ESCOs today, most Chinese ESCOs are small" (IFC, 2011). From the size and investment capacity of Chinese ESCOs, there are totally 6 ESCOs with turnover exceeding 1 billion RMB, 18 over 0.5 billion and 83 greater than 100 million RMB in 2012. Among these ESCOs, 12 had invested over 500 million RMB and 46 over 100 million RMB. As the requirement for receiving national ESCO status from MOF and NDRC was 5 million RMB registered capital, most of the ESCOs are categorized as SMEs in China. Most of Chinese ESCOs are technology-oriented, such as technology and equipment vendors. Increasing numbers of market-oriented ESCOs with existing customer base and strong financial capability but without self-developed technologies are also entering the market.

3.2.2 ESCO investments and energy savings far from potentials



	2005	2006	2007	2008	2009	2010	2011	2012
billion RMB	1.3	1.9	6.6	11.7	19.5	28.8	41.2	55.7

Figure 8 ESCO projects' investments 2005-2012 (EMCA)

Figure 8 shows that the investments in ESCO projects have grown from 1.3 to 28.8 billion RMB during the 11th five-year plan with a growth rate over 22 times. The growth rate has been steadier last year, but still at a twenty-two per cent annual rate. By the end of 2012, the total investments in ESCO projects were 50.6 billion RMB. A general estimation of the investment opportunity by International Finance Corporation (2011) excessed 100 billion US dollars (about 630 billion RMB), which means that large amount of investment opportunities still remains unexploited. From the "best practices", the project investment of single project varies from tens of thousands to over one hundred million RMB, with an average of two million.

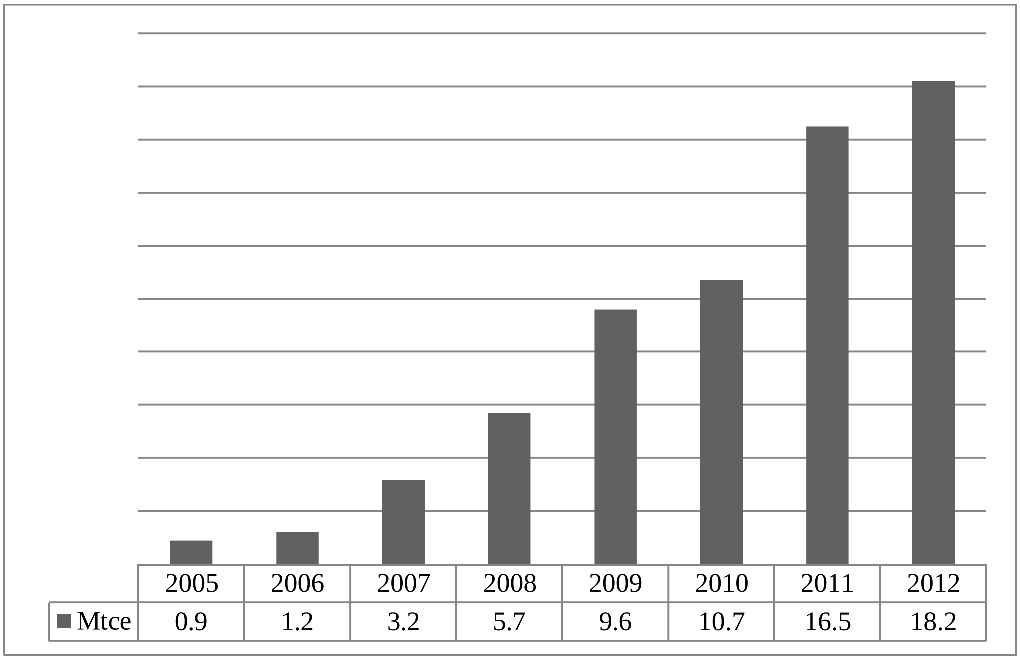


Figure 9 ESCO projects' energy savings 2005-2012 (EMCA)

Although growth rate in China's ESCO industry has been strong, the scale of the industry is still relatively small comparing to the potentials and needs of the energy conservation market in China (ASTAE 2008). World Bank (2007) estimated that technologically feasible and economically reasonable energy conservation potential in China's market exceeded 300 million tons of coal equivalence. Despite the annual growth in energy savings, the contribution of ESCO industry in fulfilling the total energy conservation potential counted only for about five percent in year 2012.

3.2.3 ESCO projects concentrating in industry sector

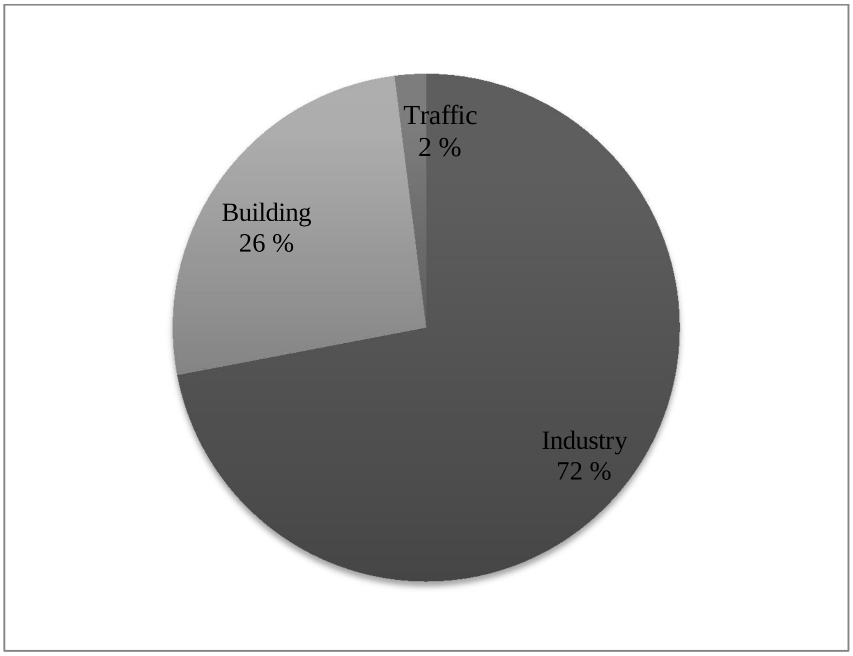


Figure 10 Customers of China's ESCOs 2010 (Li, 2011)

Li Jianwei from the development research center of the state council presented figure 10 in the "Energy efficiency solutions summit 2011". Investments in the industry sector covered a large share of the total ESCO projects in 2010. As the industry sector is the largest energy consumer in China, it is natural that most of the current energy savings are concentrating in industries such as iron and steel, pulp and paper. The types of projects are usually boiler retrofit, heat pump, variable frequency drive, combustion of waste gas for electricity generation, waste heat recovery and so on. However, ESCOs are encouraged to perform more in building and transportation energy conservations. For example, China's annual building speed is around 2 billion square meters, where most of them are energy intensive buildings. This illustrates the enormous market for building energy conservation.

3.2.4 Shared Savings model more commonly used in China

In 2007, two-thirds of the total ESCO projects were contracted by shared savings model, where ESCOs financed the investments (ASTAE 2008). Sun et al. (2011) stated in their article that based on the EMCA surveys 2007-2009, 61% of the ESCO projects were done under the shared savings model and 36% with guaranteed savings. Unfortunately more recent data was not available, but Romankiewicz et al. (2012) justified that more commonly used model in China is still shared savings due to the high preferences from government's incentive policies. All ESCO projects in the "best practices" were also implemented with shared savings contracts. The split between ESCOs and customers varied from 20/80 to 40/60. It is predictable that shared savings model will continue to dominate before the industry reaches the maturation state.

Table 3 ESCO industry statistical data (EMCA)

Year	**2006**	**2010**	**2011**	**2012**
ESCO companies (registered with MOF & NDRC)	89	782	1472 (1730)	4175 (2339)
Total value of ESCO industry (billion RMB)	4.7	83.6	125	165.3
Total number of employees in ESCO industry	16000	175000	378000	430000

3.2.5 Increasing energy prices in China

High energy prices have a positive effect on the demand for energy efficiency, especially in the industries. According to Chandlers et al. (2011), China's prices of coal, electricity and gasoline are all relatively higher comparing to United States. Shaped by the fast economic growth and unbalance between the supply and demand, the energy prices will continue to rise in China.

3.3 Government policies

As stated in the introduction, it is strategically important for the Chinese government to find a balance between ever-increasing energy demand, energy conservation and environment protection. Energy conservation through sacrificing economic growth is unrealistic for China. Therefore Chinese government has highlighted the vigorous need for energy efficiency improvement. During the 11th five-year plan (2006-2010), China had a goal to reduce energy intensity by 20 percent. To meet its target, Chinese government had developed comprehensive energy efficiency policies, such as Top 1000 energy consuming enterprises program, Ten key energy saving projects program, small plant closures and outdated capacity eliminations (Romankiewicz et al., 2012). A 20.7 percent drop met this target in reducing energy intensity from 2006 to 2011(China Daily). China has targeted to reduce energy intensity by 17.3 percent by 2015 and 31 percent by 2020 from 2010 levels in its 12th five-year plan, and a more ambitious 40-45 percent carbon intensity reduction by 2020 from 2010 levels.

3.3.1 Energy service industry promotion and development

State Council (2010) issued the Document No.25 “Opinions on the accelerating the promotion of energy management contracts to promote the development of the energy service industry” in April 2010, which encouraged the acceleration of ESCO industry development. It also promoted EPC mechanism as one of the main energy efficiency methods, increased financial support and adopted policy of taxation support. Under the document, central government will support the development of a number of large integrated energy service companies and the establishment of a vibrant market by 2012. The objective by 2015 is to have a relatively complete system of energy efficiency services, where professional ESCOs have increased their capacities to enhance the services and to expand into further sectors; to have energy performance contracting as one of the main ways used for energy efficiency improvements. The Document No.25 targeted the growth and maturation of the ESCO industry.

3.3.2 Energy savings fiscal rewards

In June 2010, MOF and NDRC released “Temporary method for management of energy performance contracting project government budgeted award funds”, a new energy savings fiscal reward policy. Under the fiscal reward policy, qualified EPC projects done by the registered ESCOs will be subsidized 240 RMB per ton of coal equivalent energy saved by the central government, supplemented by at least 60 RMB/tce from local governments. The subsidies from local government can reach as high as 360 RMB/tce for example in Shanghai, which means that ESCO can claim up to 600 RMB in total per ton of coal equivalent. The qualification requirements for ESCO registration by MOF and NDRC are: (1) Independent legal entity, which has energy saving services as main business field, (2) Minimum 5 million RMB registered capital, (3) Good business operation and credit record, and (4) matched technical professionals and EMC talents. In order to be subsidized, other requirements are a minimum energy savings of 100 tce and maximum of 10 000 tce. The project needs to be done using shared savings model, where ESCO provides 70 percent of the investments. After the local authorities, MOF and NDRC have approved the ESCO project, 60% of the fiscal reward will be paid. The rest is rewarded after the project completion and validated by approved institutions. The total amount of subsidies released by the central government in 2010 was estimated at around 2 billion RMB. Table 4 illustrates the fiscal reward policy.

Table 4 Fiscal reward policy for ESCOs

Reward from central government	240 RMB/tce
Additional reward from local government	Min. 60 RMB/tce. E.g. Shanghai 360 RMB/tce and Beijing 260 RMB/tce
Targeted energy savings	100-10 000 tce
Requirements for receiving rewards	• ESCO is qualified and registered with MOF and NDRC • EPC must be Shared Savings • ESCO provides at least 70% of the project investment capital

3.3.3 Standardization for energy performance contracting

China's National Standardization Management Committee issued the "General technical rules for energy performance contracting" in August the same year. The document standardized the definitions for ESCO and EPC as referred in Chapter 2.2.1. It also provided official contract example for shared savings ESCO project.

3.3.4 Favorable tax treatments

MOF and General Tax Bureau of China issued the "Related policy questions on value added tax and income tax with regard to advancing the energy performance contracting industry", which took effect in the start of 2011. In the new tax policies, ESCOs enjoy an enterprise income tax exemption for the first three years from the profit-generating year and 50% reduction for the next three years. The tax incentives also include exemptions of the business tax for revenue generated from ESCO projects and the value-added tax (VAT) on the free transfer of the assets to customers. From customers' perspective, VAT tax can be deducted as input tax, while business tax is not deductible (Table 5). The same requirements as in the fiscal reward policy need to be met in order to enjoy the favorable tax treatments.

Table 5 Business tax & VAT tax

Business model	**Offering**	**Business type**	**Payment of taxes**	**ESCO company's tax duties**	**Client company**
ESCO model (payment of business tax)	Energy service	Service	Business tax	Shall be paid based on the sales of service (5%), VAT of equipment purchase not deductible as input tax	Not deductible
ESCO model (Payment of VAT tax)	Energy service	Service	VAT tax	Shall be paid based on service duties (6%), VAT of equipment purchase can be deducted as input tax	Can be deducted as input tax

3.3.5 Support from EMCA

ESCO committee of the China Energy Conservation Association (EMCA) was established in 2004 during the second phase of the China energy conservation project. EMCA is the national association of ESCO industry in China. It acts as a platform among ESCOs, energy end-users as potential customers, government and financial institutions. During the eight years of its operation, EMCA has been actively promoting the EPC mechanism, supporting ESCO growth, and establishing a sustainable energy service industry.

3.4 Barriers and drivers for ESCO industry

Edward Vine (2005) has identified some key barriers to the development of ESCO industry through his international survey conducted in 2002. Other researchers (e.g. Painuly et al., 2003; Lin et al., 2004; Wang et al., 2008; Gan, 2009; Zhang et al., 2011; Kostka & Shin, 2013) have found common hurdles in their studies with some specific country-related barriers and drivers. This subchapter will first outline the barriers and then the drivers for both supply and demand sides through extensive literature reviews. The classification into market barriers, institutional barriers, financial barriers and technological barriers presented by Gan (2009) will be used to summarize this subchapter.

3.4.1 Barriers for the supply side

Majority of ESCOs in China are small and medium scale enterprises (SMEs) and the biggest barrier they are facing is the financial barrier (Gan, 2009; Wang et al., 2008). These SMEs usually don’t have large amount of capital to support project investments by themselves. Therefore, well-functioning financial intermediaries are crucial for the successful development of these ESCOs. Opposite to the ideal situation, the access to capital is limited currently, with high cost of money reflected in interest rates (Vine, 2005).

Financial barrier is not driven by the lack of available funding capacity, but rather because that the lack of awareness and willingness of the financial institutions to fund the future cash flow-based energy efficiency projects (Lin et al., 2004). As Dresseen (2011) dressed in another words, it is the inability of ESCO to access the capitals in "commercially attractive" terms. Banks in China are conservative and require solid collateral as loan guarantees (Gan, 2008). Their appraisal methods mostly focus on the revenue stream, rather than the saving stream (Painuly et al., 2003).

Characteristics as long project duration and long input-output cycle make most of ESCOs' balance sheets weak, which affects negatively in obtaining third party financing. For new emerging ESCOs, lack of credit history makes the hurdle even higher.

ESCO project may be perceived as risky because they are often non-asset based investments and collateral is difficult to obtain (Vine, 2005). The high risk is also due to the long duration of project implementation, which raises the probability of the customer's default risk. The default risk is resulted by lack of trust and societal creditworthiness (Kostka & Shin, 2013). There are no measurement and verification standards and the legal and contract enforcements are generally weak in China (Gan, 2008).

Many of emerging ESCOs were single equipment providers before. Therefore there also occurs lack of technical expertise to implement comprehensive ESCO projects through industry process line and lack of experienced human resources. Since the ESCO industry is quite new, there are not enough qualified professionals to meet the demand. (IFC 2011)

3.4.2 Barriers for the demand side

On the demand side, energy end-users are generally either not familiar with or not interested in ESCO concept and EPC mechanism. This is particularly crucial if the decision-makers of energy end-users lack the awareness of the concept. Even though the awareness of ESCO concept is increasing in China, the customers may still prioritize on the investments for growth of market size and increase in revenue. ESCO projects usually have long implementation duration resulting in long payback periods. While China's industrial managers commonly expect their investment payback to be as short as two years (Chandler et al., 2011). There are no encouragement for voluntary energy efficiency and low consideration of the benefit aspect for the environment (Zhang et al., 2011).

The lack of standardized procedures for energy audit, energy savings measurement and verification creates a barrier for customers also (Ürge-Vorsatz et al., 2007). This have caused customers to dispute with the ESCO of the energy audit results and achieved savings in some cases. The trust was presented as a market barrier for the supply side as well. “Some of the ESCO customers afraid that the energy efficiency commitment would not function as expected”. As most of the suppliers in ESCO industry are SMEs, the confidence of them providing comprehensive services and solutions are low due to the poor capabilities. (Gan, 2008)

Due to the low domestic technology level especially in advanced industry processes. There occurs a shortage of energy-efficiency technology that is economically affordable. The cost of technology imports is usually much higher, which lowers the attractiveness of ESCO projects.

3.4.3 Drivers for the supply side

The potential of ESCO market is huge in China, mainly because of the large number of highly inefficient energy intensive industries. The consensus is that the potential estimates in excess of 100 billion US dollars (IFC 2011). Large market potential is one of the main drivers for energy efficiency providers to enter the ESCO market.

The support from Chinese government is another driver for ESCO development. Favoring policies were issued, for example, Document No. 25 called for an accelerated development of China’s energy saving service industry in 2010. Favorable national tax legislation was also adapted for ESCOs and monetary subsidies for ESCO projects.

3.4.4 Drivers for the demand side

Increase in energy prices and intensive competition have made energy end-users more aware of the growing portion of the energy costs. The reduction in energy costs is the main driver for the demand side to generally consider energy efficiency improvement.

Many of the energy end-users have the need to replace or upgrade key items of energy-related equipment due to the issues such as equipment age, operational efficiency, and safety. Because of the low level of in-house expertise and skills in energy efficiency, outsourcing to ESCOs and concentrating on core competence may appear as a good option for demand side. The guaranteed saving promise increases the attractiveness to implement projects as ESCO projects.

For the energy intensive companies, there are also pressures from local authorities to demonstrate improvements in environmental performance and carbon emissions.

Table 6 summarizes the barriers and drivers discussed in this sub-chapter for research question 2. We will return to these identified barriers and drivers in the summary of empirical research results in Chapter six.

Table 6 Identified barriers & drivers from the ESCO market

Barriers & Drivers	Barriers from supply side	Barriers from demand side	Drivers from supply side	Drivers from demand side
Market	Lack of trust and social creditworthiness, long project cycle	Low awareness or lack of information, other investment priorities	Market potential in energy efficiency	Rising energy price
Institutional	Lack of M&V standards, weak legislation or enforcement	Weak legal framework, low environment protection consideration	Government favoring policies, tax reliefs, fiscal rewards	Pressure from authorities
Financial	Lack of access to capital	Lack of proper credit appraisal method	Sufficient financial return of ESCO projects	No initial investment
Technological	Lack of domestic technology and expertise, lack of experienced professionals	Fear of technical risk, lack of information	Support from national ESCO industry association	Access to technology and expertise not available in-house

4 THEORETICAL FRAMEWORK

The previous chapter studied the development of ESCO industry in China and the current market situation. The identified drivers for and barriers to ESCO were summarized into market, institutional, financial and technological categories. These drivers and barriers are general in China's market level. Narrowing down the study from general level to single energy service contract situations, this chapter will compose the Transaction Cost Economics (TCE) theoretical framework to expose the drivers and barriers of ESCO. With this approach, we hope to gain more complete understanding for the primary research question. This chapter will present the theoretical framework and elaborate Sorrell's TCE model for energy service contacting. In the next chapter, Sorrell's model will guide this study's empirical research.

4.1 Transaction cost economics

The existence of economically profitable energy efficiency investments not being realized can be explained by "market failure" and "market barriers", as this is a widely accepted explanation coming from transaction cost economics (Kavcic, 2010). There are barriers in ESCO market as any other market having transactions of goods and services. Jaffe & Stavins (1994) refer market barriers to any factors that explain why technologies, which appear cost effective at current prices, are not taken up. Similarly, Sorrell's definition (SPRU, 2000) of barriers to energy efficiency was "postulated mechanisms that inhibit investment in technologies that are both energy efficiency and economically efficient".

The concept of transaction costs was first introduced by the Nobel Prize winner, economist Ronald Coase in 1937, which was then developed into a theory by Oliver Williamson in his book "The economic institutions of capitalism" in 1985. Transaction cost economics assumes that the transactions are rarely costless and unavailable. As Arrow (1969) had stated: "Market failure is not absolute, it is better to consider a broader category, that of transaction costs, which in general impede and in particular cases completely block the formation of market".

Williamson (1989) described, “Transaction cost analysis entails an examination of the comparative costs of planning, adapting, and monitoring task completion under alternative governance structures”. Transaction costs related to energy service contracting are from the ESCOs’ perspective for example: identifying prospective customers, conducting energy audits, identifying potential energy savings, contract negotiation and closing, financing. From the customers’ perspective, costs are such as searching, contracting and monitoring.

Transaction costs have proven difficult to measure, but the determinants offer a general understanding of the barriers to energy efficiency (Golove & Eto, 1996). Goldman et al. (2005) argued that the slow diffusion rates of ESCO market could be better understood in terms of the transaction costs rather than the types of neo-classical market failures.

4.2 Sorrell’s TCE model for energy service contracting

In this decade, Steve Sorrell in his studies developed a theoretical model of energy service contracting based on the transaction cost economics (TCE) to better understand the underlying economics and the market barriers. According to Sorrell (2007), contract is viable when “the expected reduction in the production cost of supplying energy services can more than offset the transaction cost of negotiating and managing the relationship with the energy service provider”.

4.2.1 Determinants of production cost

The main determinants of production costs are the potential savings in production costs and aggregate production costs. The technical potential for production cost savings can be achieved for example by improving management efficiency or by equipment retrofits, refurbishment and replacement. The ESCOs through the economies of scales, competitive tendering and performance incentives may offer drivers in customers’ perspective. (Sorrell, 2005)

4.2.2 Determinants of transaction cost

Cited in Sorrell's study (2005), Easton Consultants (1999) pointed out that up to 40% of the total costs in US ESCO performance contracts are transaction costs (See Figure 11). According to World Bank (2007), if a given enterprise has no experience with a certain type of energy conservation investment, the time required for staff to secure information, analyze design options, identify reliable suppliers will induce high transaction costs. Originally, Williamson (1985) in his book "The economic institutions of capitalism" determined the transaction costs as investment frequency, specificity, uncertainty, limited rationality and opportunistic behavior. In 2005, Sorrell suggested under the TCE framework four determinants of transaction costs, which were asset specificity, task complexity, competitiveness and institutional context.

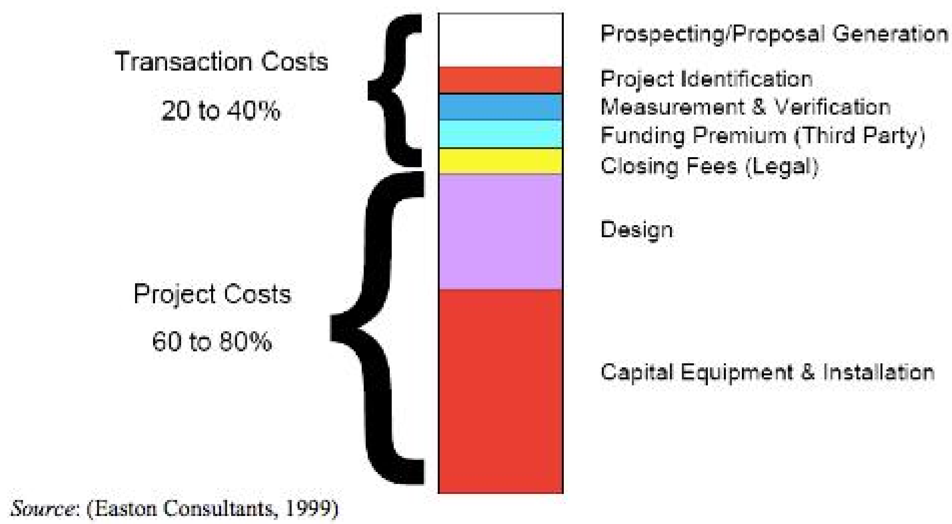


Figure 11 Percentage of transaction costs (Easton Consultants, 1999; cited in Sorrell, 2005)

<u>Asset specificity</u>

Asset specificity and task complexity are two project specific determinants of transaction cost. The specificity of physical and human assets required to provide the energy service is valued by the possibility of alternative use (Sorrell 2005). For example, money as liquidity is a non-specific asset, while the equipment integrated to customer's process systems is specific and hard to transfer. Originally Williamson (1985) presented the term “asset specificity” as “specialized assets cannot be redeployed without sacrifice of productive value”. Sorrell defined three types of specificities: site specificity related to the relocating possibility of investments and the resale value. Physical asset specificity in performance contracting is related to the sunk costs of pre-contract energy audit. Human asset specificity is related to the specialized knowledge and expertise to provide the energy services. Mainly from the ESCOs’ perspective, asset specificity creates a problem of safeguarding against opportunism. The higher degree of asset specificity results in higher vulnerability of investing side to be exposed to opportunism behavior of the other side, therefore asset specificity increases transaction costs (Sorrell 2005).

Task complexity

According to Sorrell (2005), the task complexity refers to difficulty degree of energy services in general and the costs of specifying and monitoring the contract terms and conditions. If the conditions are poorly defined, it may expose one of the contracting sides for opportunistic behavior (Kavcic, 2010). Increasing level of task complexity also generates greater environmental and behavioral uncertainties. Hereby environmental uncertainty refers to the changes in internal and external factors, which creates an adaptation problem. Behavioral uncertainty refers to the increase of asymmetry information between ESCOs and customers, which creates a measurement problem. Both of the uncertainties lead to direct and opportunity costs, which reflects to higher transaction costs.

Competitiveness

Competitiveness is one of the two transaction cost determinants that is common to all ESCO projects. Institutional context described in the next paragraph is the other one. Competitiveness of the energy service market was presented as the third determinant of transaction costs. The potential of opportunistic behavior increases when competitors in the market are limited. On the contrary, in the competed and contestable market, opportunism has no implications and should result in the decrease of transaction costs.

Institutional context

The political, economic, legal and financial frameworks were summarized as institutional context. Under supportive contexts, the transaction costs are lower. Sorrell (2005) identified that, these supportive "encouragements" could be such as information dissemination; standardization of public procurement procedures, monitoring and verification protocols and contract models; accreditation of ESCOs; and consultancy.

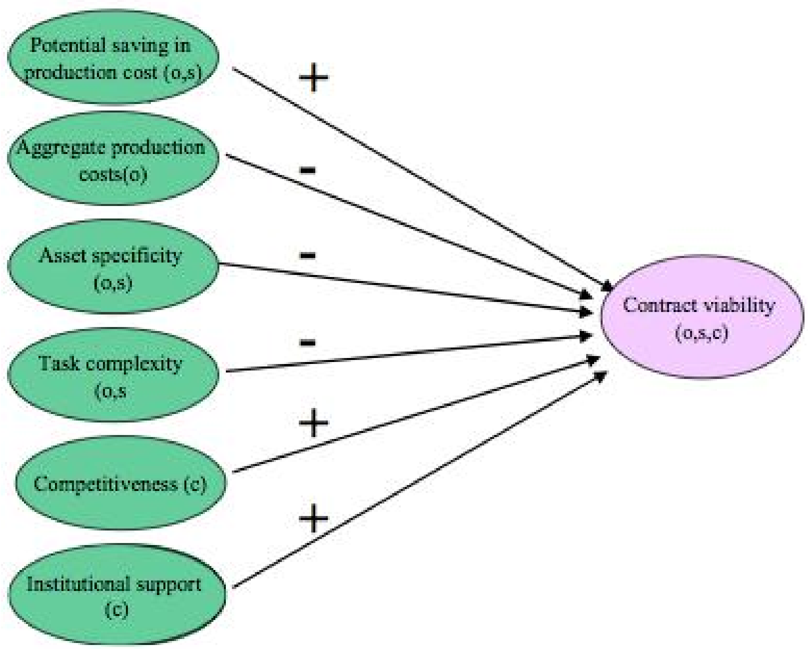


Figure 12 TCE model for energy service contracting (Sorrell, 2005)

The figure above summarizes Sorrell's theoretical model. The favorable determinants of production cost are high potential saving for customers and low aggregate production cost. On the transaction cost side, favorable circumstances are low asset specificity and low task complexity, while externally high competition in ESCO market and high institutional support.

Under the TCE model, Sorrell (2005) also suggested six hypotheses (Figure 13) to be tested through empirical research for the future studies. Action was taken in the empirical research of this study to test the effects of production and transaction cost determinants in resulting of viable ESCO projects; and to find out the perceived drivers and barriers from the perspective of ESCOs (See research question 3). We continue with the empirical research in the next chapter.

Energy service contracting is more (less) likely to be used in situations where:

- *H1:* the technical potential for production cost savings for the energy services included within the contract are large (small);
- *H2:* the aggregate production costs for all energy services within the client organisation are small (large);
- *H3:* the specificity of the assets required to provide the energy services included within the contract are low (high);
- *H4:* the task complexity, as measured by the difficulty in specifying and monitoring contractual terms and conditions is low (high);
- *H5:* the market for energy service contracts is more (less) competitive;
- *H6:* the relevant institutional framework is more (less) conducive to contracting.

Figure 13 Hypotheses regarding the viability of energy service contracts (Sorrell, 2005)

5 EMPIRICAL RESEARCH

Several studies have indicated that ESCOs are far from fully utilizing their potential. The ESCO literature provided reasons for it from neo-classical, behavioral and organizational point of views (SPRU 2000), but there are no empirical research done in China under the transaction cost economic framework. Therefore, it would be beneficial to identify the important barriers and drivers of Chinese ESCOs explored through the TCE framework. This chapter introduces first the data collection method chosen for the empirical research, then the research design and process. The findings will be presented in the next chapter. The transaction cost economics framework by Sorrell (2007) serves as the starting point for the interview design and the questions are formed based on the determinants of production and transaction cost to identify the perceived barriers and drivers.

5.1 Research design

5.1.1 Semi-structured interviews

Järvinen (2004) described the interview as a conversation between researcher and interviewee to elicit valuable information from the interviewee. Interview was chosen as the data gathering method for this empirical research. According to Given (2008), the semi-structured interview is a qualitative data collection strategy that involves researcher asking interviewees predetermined but open-ended questions. By asking open-ended questions, interviewees are usually encouraged to give opinions and perceptions in their own wordings. Semi-structured interviews provide more control over the topic comparing to unstructured interviews but are more flexibility than closed interviews or questionnaires (Given, 2008). This also reduces interviewees' self-reporting nature in data collection. Generally, researcher plans the interview flow beforehand with list of predetermined questions. Based on each interview situation, researcher may vary the wording and the order of questions to create the most natural conversation (Eriksson and Kovalainen, 2008). The goal is to gain qualitative information for the research questions related to the concepts or phenomenon under investigation (Given, 2008).

5.1.2 Sample of interviewees

The selected interviewees should be somewhat homogenous and share critical similarities related to the research question (DiCicco-Bloom & Crabtree, 2006). In this empirical research, six ESCOs were selected. Five of the six sample ESCOs were registered with NDRC and MOF. Additionally, these selected ESCOs represented the technology-oriented and market-oriented ESCOs, private companies and group subsidiaries, ESCOs in both industry and building sectors. By covering different type of ESCOs, we believe it will increase the general validity and reliability of this empirical research.

5.1.3 Formulation of interview questions

The interview opens with introducing to the topic and asking permission for tape recording. In the background section, general information about the interviewees' companies is asked. The background questions are divided into main questions as company size, offerings, ESCO projects and ESCO status. These questions are continued with possible follow-ups and prompted with specifying questions.

The six determinants of production and transaction cost (potential savings in production cost, aggregate production costs, asset specificity, task complexity, competitiveness and institutional contexts) are used as the themes in the pre-determinate open-ended questions in the following six sections. Under each determinant, 7-point Likert scale scores from entirely disagree to entirely agree are used to test Sorrell's hypothesis (See figure 13) among the ESCOs as opinion questions. This can be seen as adductive reasoning, where theories prior the data collections are validated through the data (Hirsjärvi & Hurme, 2008). Use of 7-point Likert scale can minimize interviewees' extremeness aversion behavior.

To explore the perceived barriers and drivers, several open-ended direct questions will be asked around each determinant. After direct questioning, follow-up questions are specified to elaborate interviewees' answers. Direct questions' formulation is influenced by Sorrell's (2005) UK survey design (See Appendix A). Despite that Sorrell's survey attempt ended with statistically insignificant results caused by low response rate, it still act as the starting point for this empirical research to test the hypotheses and find out the perceived barriers and drivers. The entire interview plan can be found in Appendix B.

5.2 Research process

Face-to-face interviews were conducted, since it allows the access to nonverbal information expressed by the interviewees. According to Shuy (2003), by being in the same space with the interviewee, researcher can better establish a good rapport for more fruitful data collection. The interviews were conducted in China between March and April 2013. The interviews lasted between 60 to 120 minutes. Place where interviews took place were in the Capital area of China. All interviews were recorded under the interviewees' permissions and all interviewees remained anonymous in this report. A total of six semi-structured interviews were conducted with senior management level representatives of these companies, examining the size, scope and nature of their business, contract types, market competitiveness, transaction costs, government policy initiatives, barriers and drivers for contracting. Due to the language barriers among Chinese ESCOs' representatives, the interviews of this study were conducted in Chinese. Therefore, the transcription was highly dependence on author's ability to understand, interpret the verbal and nonverbal information provided by the interviewees from Chinese to English. The interviews were transcribed, reread and combined with notes during interviews and immediate impressions written down after the interview situations for research analysis and result presentation. Next chapter will present and summarize the empirical findings from these interviews.

6 EMPIRICAL FINDINGS

The empirical research results aim in providing answers to the primary research question: under Sorrell’s transaction cost economics (TCE) framework, justify the effects of the production and transaction cost determinants in resulting of viable ESCO project. How Chinese ESCOs have perceived the previously identified drivers and barriers under the TCE framework? The result presentation will follow the sequence of interview plan (See Appendix B).

6.1 Background

As described in the research design, background information was asked in the start of each interview. From the six interviewed ESCOs, four were subsidiaries of Group Corporation and two were private companies. Four of them focused on customers in building sector and two operated in industry sector. Two were registered with NDRC & MOF in the first batch, two in the third batch, one in the fourth batch and one yet without registration. The headcount varied from 20 to over 900. Compared in size, five were SMEs and one was listed company. The overview of interviewed ESCOs’ background is listed in Appendix C in chronological order.

6.2 Determinants of production cost

Sorrell’s framework was originally developed to assess the viability to entry an energy service contract. According to Sorrell (2007), the total savings in production costs must be greater than the transaction costs in order to have an economically viable energy service contracting. The two production cost determinants were the potential savings in production costs and the aggregate production costs. In Sorrell’s model, these production cost determinants were highly project specific and mainly influenced by the size and nature of the customer. Notwithstanding, we included the determinants of production cost to investigate the barriers and drivers to ESCOs. Since the focus will be on the determinants of transaction cost in the following paragraphs, production costs will be only briefly explored.

6.2.1 Potential savings in production cost

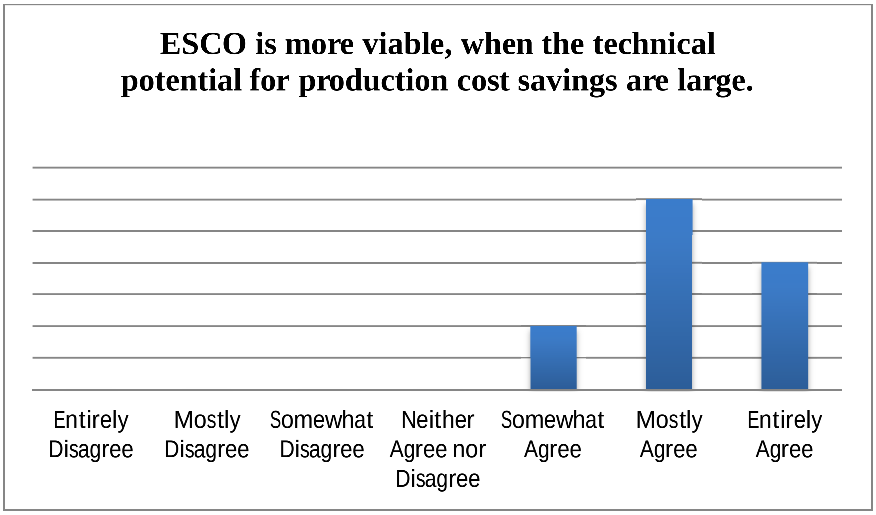


Figure 14 Opinions on potential savings in production cost

All interviewees agreed to some extent with Sorrell's view that the larger the saving in production costs, the greater the viability. The saving in production costs relates to energy cost saving potential through technical and organizational improvements compared to the historical performance. The size variable had an impact on ESCOs' opinions in these interviews. For smaller ESCO with limited capacity, customer's large technical potential for production cost savings may not necessary is a favorable determinant, especially if ESCO cannot meet the requirements to realize the potential. Therefore from ESCOs' perspective, the viability is related to the size of ESCO.

Under this theme, we asked how ESCOs have perceived customers' expectations toward ESCO projects. The purpose was to examine how ESCOs perceptions of drivers for customers fit to the previously identified drivers from demand side in chapter 3.4.4. The results show that the perceptions from Chinese ESCOs correspond with the identified drivers.

All interviewees agreed that the economic benefit from energy cost savings is the largest driver for their customers. Beside this, one ESCO also highlighted that "The customers expect minimum disruption to their normal operations during the ESCO project implementation".

The private-owned enterprises are generally more ready for ESCO projects, due to the expectation of economic gains through energy cost savings. Majority of the interviewed ESCOs described the energy conservation motivation of state-owned industries and governmental buildings as passive. In China, state-owned enterprises (SOEs) usually still practice planned economy. The managers of SOEs also hold concurrent posts in the government. Between these two roles, there occurs a conflicting interest. The savings in energy cost is not the primary objective for factory managers, because lower expenditure could mean that the next year's budget will be pruned.

There are pressures from local authorities to demonstrate improvements in environmental performance and carbon emissions. Large-scale enterprises are more likely supervised by the environmental authorities. "It poses also a dilemma for local authorities as the large-scale enterprise may also be the greatest single source of taxation for the city. Therefore local authorities sometimes doesn't press the environmental issues effectively enough", said by one of the interviewees.

In the building sector, the energy-saving potential of individual building is very limited. ESCOs have to seek opportunities to bundle the buildings for better viability. The economies of scale will be discussed next.

6.2.2 Aggregate production costs

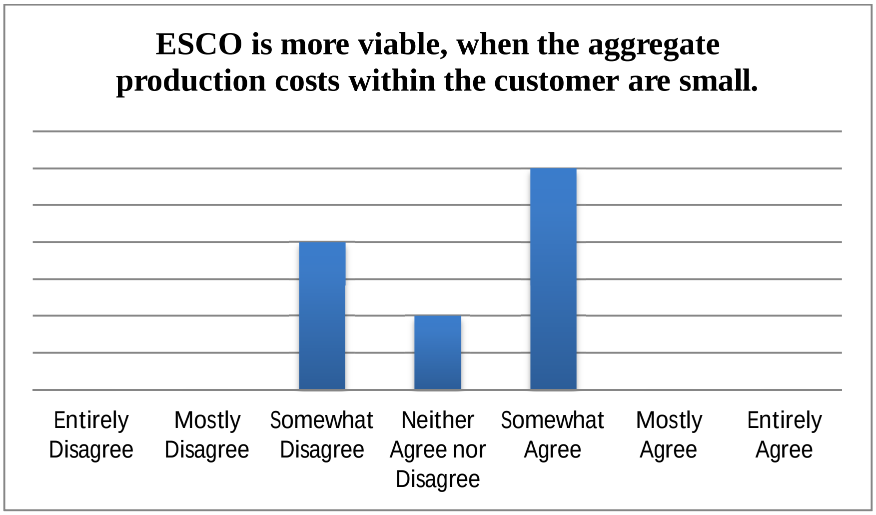


Figure 15 Opinions on aggregate production costs

Sorrell (2005) expected that ESCO's advantages in terms of economies of scale fall as the size of energy end-user increases. The size of client is referred to aggregate production costs for energy services for all the sites owned by the client. This hypothesis was somewhat unclear among interviewees. From one point of view, one interviewee states that "shouldn't it be opposite, the bigger aggregate production costs, the greater the viability". Beside the customer's size variable, the perception was also affected by the size of ESCO. Smaller ESCOs tended to disagree with this hypothesis in these interviews.

Due to economies of scale, ESCOs may have an advantage comparing to customers' in-house performance. This point of view was enquired through the interviews and the results confirmed that most of the interviewees believe that they outperform customer's in-house provision with more extensive access to information, advanced core technology, specialized professionals and efficient management skills. For ESCO companies under the umbrella of corporation groups, they are more privilege to enjoy the economies of scale.

6.3 Determinants of transaction cost

Sorrell defined the four determinants influencing the transaction costs as asset specificity, task complexity, competitiveness and institutional context of the market. Among these, the first two were project specific and remaining two were market specific. The barriers and drivers perceived under the market specific determinants offer more descriptive power as they may be generalized across the common market.

6.3.1 Asset specificity

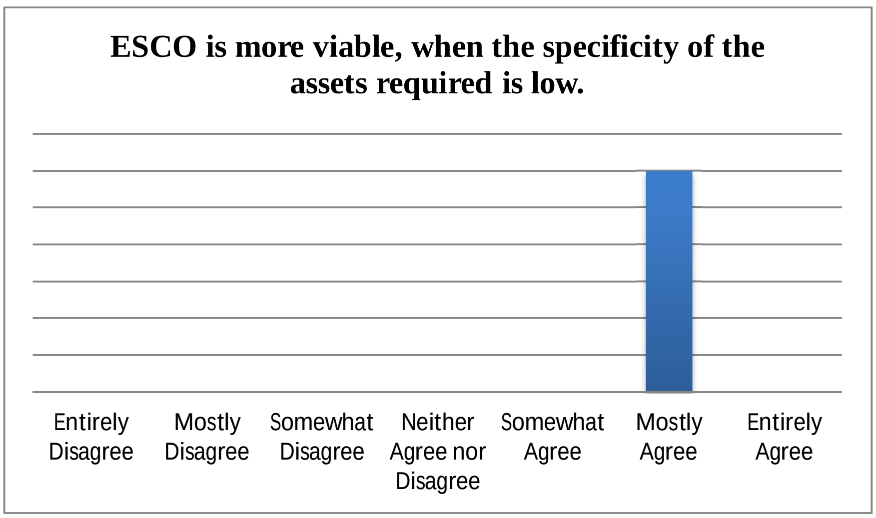


Figure 16 Opinions on asset specificity

In Sorrell's (2005) hypothesis, as asset specificity increases transaction costs also increase, making the ESCO contracting less viable. Hereby, asset specificity refers to the "sunk costs" by physical and human assets prior to and during the term of contracting that are nontransferable or with little savage value. Interviewees unanimously shared this opinion. During the interviews, we asked about the customization level of ESCOs' offering, the knowledge and expertise level of ESCOs to perform the projects and the possible energy audit investments. From these questions, we wanted to examine, how Chinese ESCOs have perceived asset complexity as a barrier or driver.

ESCO business is technology-intensive. Continuous technology improvement is an important factor for ESCOs to maintain core competitiveness. To achieve this, the stable core technical personnel are the bases. All interviewed ESCOs have strong internal knowledge and expertise, but most of them also have close cooperation with external experts from education and research institutions. The need to acquire information from outside wasn't seen as a barrier by the interviewees, but the difficulties of obtaining core technical personnel was raised by one of the interviewed ESCOs, "While the market competition becomes fiercer, company has to continuously satisfy key employees intrinsic and extrinsic motivations in order to keep them in-house". At the moment, the rise of labor costs in China has still relatively small impact on companies' profitability.

Specificity of assets varies between ESCO projects. Depended on ESCOs product and service offerings, there was a polarization of the customization level. For example in buildings' lighting solutions, the product (LED lights) offered to customers is a standardized mass product. On the other hand, waste heat power generation solutions were highly site specific and required detailed customization. One of the interviewees summarized that "generally all products and services need to be customized to fit different customers' needs. This can't be seen as a barrier, since the possible risk can be avoided through proper contract terms".

The pre-contract energy audit is necessary for all ESCO projects. For smaller projects, it may end up as "sunk" cost that never pays off. For large projects, ESCOs may also offer the energy audit as a separate service to avoid the economic loss from not contracting, but it is very rare. Some of the interviewees said that "the pre-contract energy audits are made free-of-charge, because this has been the unwritten industry practice". The pre-contract energy audits are mostly done by the ESCOs themselves, but some customers may also request third-party institutions to perform the energy audits.

6.3.2 Task complexity

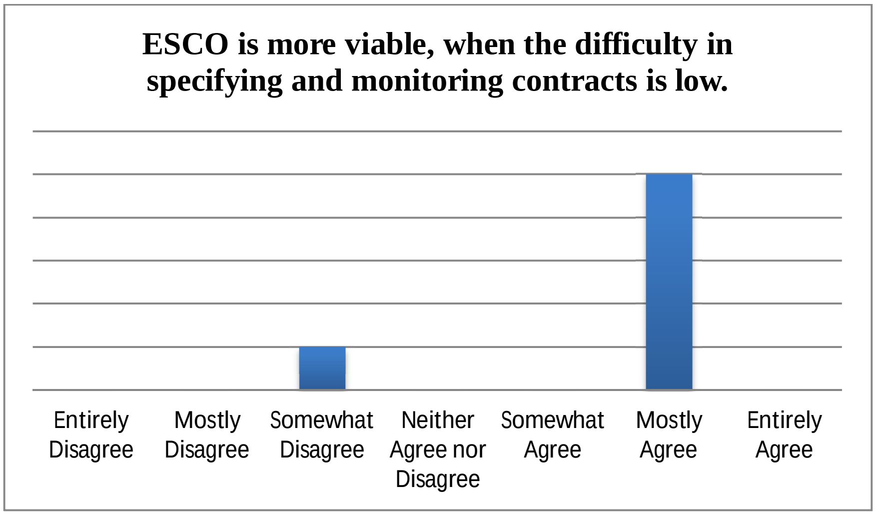


Figure 17 Opinions on task complexity

Sorrell (2005) expected the transaction costs for specifying and monitoring ESCO contracts to increase when the task features greater complexity. This was generally agreed by the interviewees, but one has questioned that "in the real life, if the task is simple and straightforward, there would be no need for ESCO since energy end-user can complete it itself". The disagreement was related to the general complexity of the task and its effect on energy service contract's viability. From the contract specifying and monitoring aspect, the opinions were consistent with the hypothesis. We re-contacted the interviewee with divergent opinion to ensure this (25.04.2013).

Under the task complexity determinant, the overall complexity of ESCO projects was discovered. Theoretically, high complexity of the project exposed one side to act opportunistically. Based on the responses of interviewed ESCOs, we see that the ESCO projects are generally complex in nature. Technologically, it requires professional teams in both engineering and construction. More importantly, indicated by one of the interviewees, "For a single project to proceed in China, it needs approvals from over 20 government authorities within their state level, provincial level and local level departments, meaning over 200 stamps. These government authorities are for example national development and reform commission, ministry of environmental protection, ministry of information and technology and different departments under the ministries." Another

Chinese ESCO argued that the view might be exaggerated, but agreed "public relations have always had an important role in doing business in China. Chinese ESCOs have to put great efforts and invest big amount of resources to make the stakeholders satisfied".

As we mentioned in chapter 3.3.2, Chinese government has issued a model contract for ESCO projects in the "General Technical Rules for Energy Performance Contracting". The model contract has been widely used among ESCOs and parties are satisfied with the terms defined in the model contract. The standardized contract model by the government is agreed as a driver by the interviewed ESCOs.

The difficulty of monitoring and verification in ESCO projects was previously identified as one of the barriers for both supply and demand sides. This aspect was investigated through direct questions and ESCOs' opinions had polarized on this issue. Some of ESCOs hadn't experience any difficulty with customers in energy saving monitoring and verification, while others had undergone challenges. The characteristics of energy conservation technology are one of the main reasons. "For us, energy saving amount is measured and validated through electric energy metric. It is simple, accurate and transparence", said by ESCO, which found M&V straightforward. On the other hand, another ESCO stated, "In the building sector, the amount of annual energy saving is highly influenced by the external climate. Customers are sometimes diffused of the energy savings by either ESCO project or climate change". "Beside the external uncertainty factors, another reason for M&V difficulty is caused by inaccurate basic data provided by the customers", reasoned by another interviewee. National monitoring and verification standards for different sectors were strongly desired by those ESCOs facing difficulties.

In industrial ESCO projects, the energy saving potentials is interconnected with energy end-users' production performances. Before contracting ESCOs also have to carefully evaluate the performance risks of their customers. With predefined terms and conditions, ESCOs can avoid failure caused by customers' production shortage.

6.3.3 Competitiveness

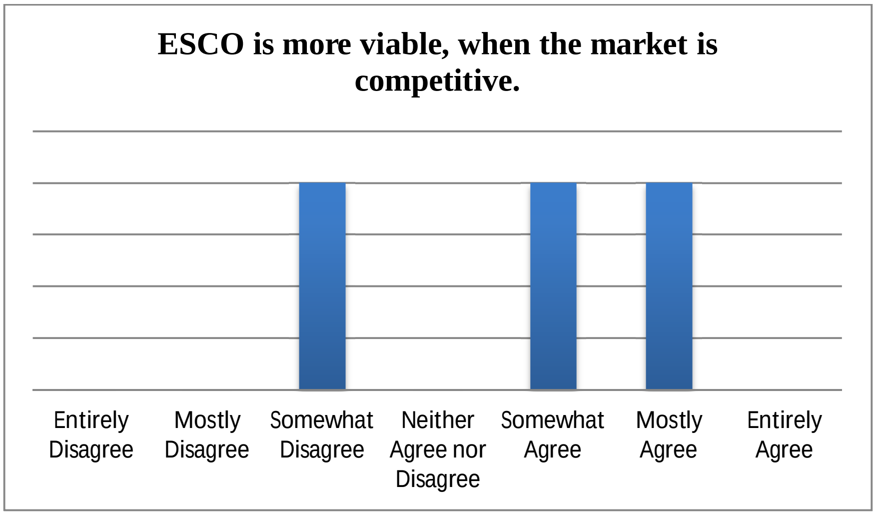


Figure 18 Opinions on competitiveness

Hypothesis of "ESCO is more viable, when the market is competitive" found divergent echo among interviewees. "From ESCO's point of view, increased competition inspires us to invest in research & development and to generate more efficient and effective energy efficiency technology for the market, but it also has negative impacts such as cutthroat competition in project biddings" commented by one of the interviewees. Competitive market made customers' bargaining power stronger and ESCOs will face difficulties in survival without self-developed technologies or own customer base. Customer relationships with strong mutual trust also reduce the possible negative effects to ESCOs. These were the main variables behind the divergent opinions.

Under this theme, the interview questions investigated the underlying market competition in-depth. The direct questions were asked about the competitors of the interviewed ESCOs, the general competition in the industry, the market entry requirements and the future expectations.

ESCOs perceived differently about their direct competitors. For ESCOs with more standardization and lower technology, they have found more competitors with comparable offerings. Regarding the competition in the industry, ESCOs agreed that the market competition is getting fiercer; as many ESCOs are newly established under the favoring policies and foreign

ESCOs have targeted China to be their next “cash cow”. “The competition is intensive and there are even copycats in the market”, one ESCO complained.

Some of the interviewees perceived that as the early entrants, some ESCOs enjoyed the market dominance due to the demonstrative effect of previously successful projects. Although there are some entry barriers for new players in terms of capital, technology, human resource, operation management and value chain integration, the increased market awareness of ESCO and market demand attract more and more competitors. “The requirements for ESCO are relatively low and many new players are market-oriented without any core technology”, pointed out by one of the interviewees. Self-developed core technology and reputation offer some differentiation edge, but if the early entrants cannot secure their financing channels and maintain their technology advantages, it will be difficult for them to consolidate the market dominance.

In the follow up questions, the perceptions of competitiveness as either a barrier or driver were elaborated. Generally, interviewees have received both conducive and inhibitory effects. “While rivalry get more intense between ESCOs, it push everyone for continuous development and can result in better solutions for the customers”, stated by one of the interviewees. “On the other hand, our pricing is negatively affected by the increased competition, shrinking the profit margins. In the long run, it may be a barrier” added by another ESCO.

“The market positions may be reshuffled in near future. The trend is toward super ESCOs operated by the large SOEs. Small and private-owned ESCOs will be merged and acquired”, estimated by one interviewees. Government authorities have also started the annual examination with registered ESCOs. Registered ESCOs with less than two ESCO projects or 100 tce savings per year will have their status withdrawn. Most of interviewees agreed with government’s attitude to tighten the requirements. All ESCOs were confidence that the ESCO industry will reach its full potential in the near future.

6.3.4 Institutional contexts

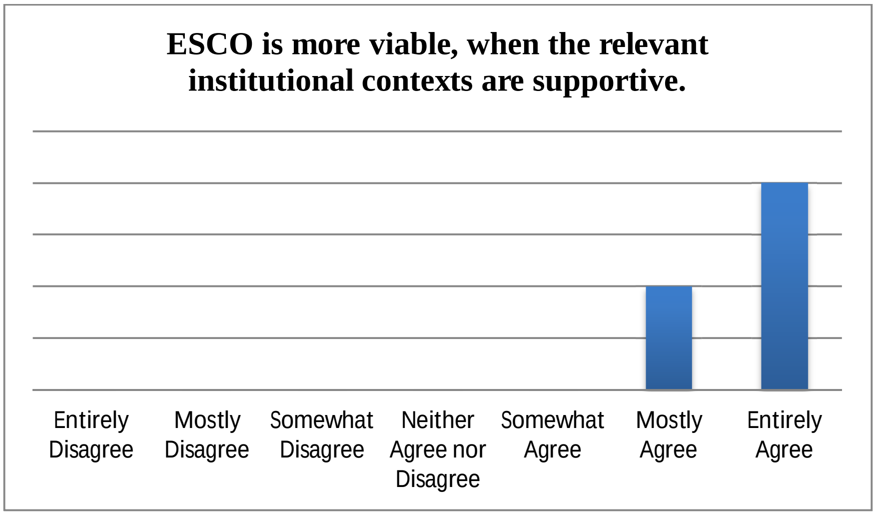


Figure 19 Opinions on institutional contexts

Sorrell stated that the transaction costs are also depended upon the institutional contexts. The institutional context determinant was divided into political, legal, economic and financial frameworks. According to the hypothesis, ESCO is more viable, when the relevant institutional contexts are supportive. Interviewees had a consensus and agreed upon this hypothesis. The differences between mostly and entirely agree can be understood by extremeness aversion behavior.

The existing barriers and drivers from industrial and governmental sources suggested that government's supportive policies have a positive impact on ESCOs. Through the direct questions about these driving policies, we understood that interviewed ESCOs were aware of the government's supporting policies. The tax incentives and fiscal rewards were also available, but the enforcement of government policies in the local level was sometimes delayed. Some of the interviewees were satisfied with the current supporting force from the government, while others hoped for yet stronger fiscal rewards. Despite the availability of the subsidies, some had surprisingly stated that the ability to enjoy them was highly dependence on the personal network and relations with the related government departments. As it was said by one of interviewees "There are thousands of ESCO projects meeting the subsidy requirements, but government's reward budget is only enough for some of them. In order to be one of the companies receiving the subsidies, ESCO needs to have strong network with the government." Although the network was raised as essential in doing business in China by interviewees, it shared opinions of its actual role as driver or barrier in ESCO business. Some argued that "The network could decrease the negotiation cost and increase the mutual trust, but it is not the only element needed for success".

Despite of some complexity to receive the tax incentives, the benefit of income tax exemptions could be very large. For one interviewed ESCO "the tax incentives accounted for over 30% of the annual net profits". ESCOs enjoy an enterprise income tax exemption for the first three years from the profit-generating year and 50% reduction for the second three years. After the expiry of the preferential tax policies, ESCOs' operating results may be adversely affected due to the increase in income tax expenses.

After the companies received the fiscal rewards, there were differences between ESCOs as how they managed the rewards. Some ESCOs gave them directly to their customers as a negotiation mechanism to attract customers. Some ESCOs shared them with customers under a predefined split. Some included the subsidies as a discount factor in pricing. There were also ESCOs who kept it all to themselves. The interviewed ESCOs hoped for easier approval process in the future. All in all, the rewarding policies weren't seen as a decisive element in project contracting. As the subsidies are mutually exclusive, receiving the ESCO subsidies may result in not enjoying other rewards.

The general legal framework was explored by asking about the legal enforcement, contracting and M&V standards. The public procurement procedures were also one of the direct questions. As a developing country, China's legal system is still far from reaching its perfection. "In the legal environment, the principle of good faith needs to improve. Noblemen respect and obligate the consensual contract, but there are also villains acting opportunistically harming the mutual benefits", indicated by one interviewee. Right self-guarding costs in China are high. The course of a judicial processing is economically heavy, complex and time-consuming. "For ESCO companies, protection through legal recourse is the last and least pleasant option", same interviewee continued. The business environment in China is highly dynamic and the lifecycle of enterprise could be very short. "Merger and acquisition happens every day, especially for small- and medium size enterprises. Therefore there are little payment guarantees and debt collection costs sometimes more resources than the core business", complained by one of the interviewees. ESCOs have to carefully evaluate their customers before contracting, which increases the transaction costs. The national M&V standard was yet established and the international performance measurement and verification protocol was poorly applied in China. The public procurement procedures differ between provinces. Depending on the location of project, ESCOs have to familiarize with the local practices.

Regarding the economic framework, effects of external factors as energy price, financial crisis or economic downturn were enquired. All interviewed ESCOs agreed that the increase in energy prices has a driving boost toward ESCO industry. "For example, the coal price per ton was 455 RMB in January 2006 and was up to 900 RMB per ton with an 87 per cent growth rate", one of the interviewees stated. Energy end-users' demand for energy services follows the increase of energy prices. The effect of economic downturn has two sides. For energy end-users, they may shift their priority toward energy conservation while production demand is weak. But then, if the financial stability of customer could not be secured during the depression, it will certainly cause negative effect to ESCOs.

Under the financial framework, the access to capitals was previously seen as a major barrier for ESCOs among industrial and governmental sources. The questions were formulated to investigate ESCOs' financing channels and the awareness of financial institution toward ESCO. ESCO is a capital-intensive business, which needs substantial capital investments in order to achieve continuous growth. If the company cannot acquire the financial funding required for the project investments, the negative impact will be strong. The company will not only confront delays in project construction schedule, but also facing the claims by customers causing economic losses. It is generally easier for large corporate group to access to capitals. Currently the financial institutions are getting more aware of the ESCO concept and the willingness to participate has also increased. Some commercial banks have also established offices specialized in energy conservation project financing. "Of course, without proper guarantees, the financing through financial institution is still a sea of troubles" reminded one of the interviewees. Answered by another ESCO, 20% of their project investments are funded by their own capitals from the shareholders and previous projects' profits, while the rest from the financial institutions. Other ESCOs had also similar arrangement as self-funding for smaller projects (investments less than 10 million RMB) and FI financing for larger ones. With the FI, the arrangements were that future energy savings related cash flows and invested equipment as collaterals, sometimes also the company's equity and shareholders' personal properties as guarantees. To secure the financing channel, some SMEs have also chosen to finance through capital market by launching in stock exchange.

We have discussed the results from interviews under Sorrell's TCE model. Next subchapter will summarize these results to answer this study's primary question. To summarize the findings related to barriers and drivers from empirical research, we will reuse the classification into market, institutional, financial and technological categories in Table 7.

6.4 Summary of findings

6.4.1 Sorrell's hypotheses

From the sample population testing Sorrell's hypotheses, we found that there are some relevant variables affecting the opinions toward these hypotheses. In the two production cost determinants, both ESCO's and customer's size were the variables dividing opinions. Smaller ESCOs tended to disagree with the hypotheses. The relation between ESCO and customer shaped by bargaining power and trust also impacted the opinion toward market competitiveness. Another variable related to the opinions of market competitiveness is that whether the ESCO was technology or market-oriented. ESCOs without own technology or customer base were divergent with this hypothesis. Sorrell's explanatory model for energy service contract's viability could be completed with these variables.

6.4.2 Market drivers and barriers

The information dissemination and education mainly by the industry association have increased the awareness among ESCO's shareholders. Despite the increased public awareness, the motivation and pressure of energy end users for energy conservation still have space for improvement. This concerns especially SOEs in industry sector and public institutions in building sector. The increased market awareness of ESCO and market demand attracts more competitors. Fiercer competition reduces the profit margins and increases the pressure for customer seeking. The market entry requirements are relatively low, but the government has started some actions such as annual status examination. Some ESCOs rely on one single corporate customer. High dependency on a single customer source increases the business risk of those ESCOs. China's business environment is highly dynamic, frequent M&V and even bankruptcy increase the uncertainty for lengthy ESCO contracts. From another point of view, the uncertainty is also reflected by the poor credit system and improper societal creditworthiness environment. ESCO's reputation and demonstrative effect of previously successful ESCO project are driving forces in the market. External factors as increasing energy prices and economic downturn are also positive drivers from ESCOs' perspectives. Expensive use of energy and priority shift from business expansion toward cost reduction increases the interests in energy efficiency and ESCO.

6.4.3 Institutional drivers and barriers

From the end of 11^{th} five years plan, Chinese government began to strongly promote the ESCO industry with concrete targets and supportive policies. The fiscal rewards and favoring taxation are essential drivers for ESCOs. Unfortunately the subsidy approval and receiving processes are sometimes long and complex. The enforcement of government policies in the local level is also sometimes delayed. The difficulty in enjoying government's supportive policies substantially lessens the driving effect. ESCOs have to have strong relations with related authorities in China. The existing legal framework offers relatively little protection for stakeholders and there are often little payment guarantees. The right self-guarding is also economically heavy and time-consuming process, being a barrier. China's National Standardization Management Committee has established a standard contract model, which has been widely applied in ESCO projects. This has helped stakeholders to decrease the transaction cost of contracting. The monitoring and verification standard has yet established, which has inhibitory effect for performance contracting.

The bid procedures vary among the regions, the ESCOs have to familiarize with the local practices in different projects.

6.4.4 Financial drivers and barriers

Awareness of financial institutions has increased due to information dissemination and some commercial banks have also established departments specializing in energy conservation project financing. There occur still difficulties for SMEs in accessing the capitals, especially when they lack proper collaterals. For ESCOs with limited circulating funds and shortage in financing channels, shared savings model is very hard to implement. The successful precedent of SME ESCO launching in Shenzhen Stock Exchange offers an alternative to secure the financing resource. Without access to capital, the growth of ESCO will be severely constrained.

6.4.5 Technological drivers and barriers

In the technology-intensive ESCO business, the technical professionals are the cores. Lack of experienced personnel or difficulty in obtaining them will result as a barrier. The active act of EMCA in training program arrangements has fostered the capabilities of ESCO professionals. The general technical innovation level in China is low. For the supplementary devices, the quality of domestic products is not high enough to meet the requirements. It is essential for technology-oriented ESCOs to invest in R&D and continuously improve their core technology. Strong internal technology and expertise are driving elements for ESCOs. Cooperation opportunities with experts from authoritative education and research institutions will boost the overall industry. On the other hand, the characteristics as high customization and “free” pre-contract energy audit in the ESCO projects increases the risks and may evolve as a barrier if not managed properly. The summary of findings is illustrated in next table.

Table 7 Perceived barriers and drivers from ESCOs' perspective

Barriers & Drivers	Barriers from ESCOs	Drivers from ESCOs
Market	• Intense competition for customers and technical experts • Decrease in profit margins • Information dissemination and public awareness • Uncertainty in market dynamics with abrupt M&As • Lack of trust and social creditworthiness	• Market potential in energy efficiency • Pressures from authorities for intensive energy end-users • Economies of scale • Reputation and demonstrative effect of successful projects • Increasing energy prices • Economic downturn
Institutional	• Complexity in project approval from authorities • Long and complex approval process for subsidies • Costs from public affairs and government relations • Lack of M&V standards • Weak legal enforcement and high right self-guarding costs	• Government favoring policies as fiscal rewards and tax exemptions • Standard contract model
Financial	• Difficulties in accessing capitals • Shortage in financing channels	• Increased awareness of FI • Sufficient economical return of ESCO projects • Launch in stock exchange
Technological	• Lack of domestic technology and expertise • High customization • Sunk cost of pre-contract energy audit • Low technical innovation level	• Strong internal knowledge and expertise • Cooperation with experts from education and research institutions • Support from national ESCO industry association

7 CONCLUSION AND DISCUSSION

This study clarified the terminology that falls under Energy Service Company (ESCO) and Energy Performance Contracting (EPC). By reviewing the extant literature, it increased the overall understanding of ESCO development in China from past to the present state. This study also identified the drivers for and barriers to ESCO market discussed in industrial and government sources. In the empirical part, semi-constructed interviews were done with six ESCOs in China. The interview data were collected, taped, transcribed, coded, analyzed and the findings were discussed. In terms of theoretical implications, this study contributed to knowledge about the ESCO drivers and barriers in China by applying the transaction cost economics framework. According to the current knowledge, this was first empirical investigation about ESCO barriers in China through the determinants of transaction cost.

7.1 Limitations

This study, as most of the studies, was limited both in time and resource. From the recommended list of ESCOs from EMCA and list of registered ESCO by NDRC & MOF, we had a large candidate list. It was still hard to arrange meetings with Chinese senior level managers under the "student" status; therefore helps from Finnish Trade Center in Beijing were applied. Due to the difficulties confronted in interview arrangement, this study was able only to conduct six interviews. The importance of the drivers and barriers discussed is mostly applicable at the place and time where the interviews were conducted, and therefore the findings may not be applicable to other countries. In this study, the interviews were conducted in the Capital area of China, Beijing.

For the theoretical framework selected, Sorrell's TCE model has one of the limitations. The model excluded the role of trust in mitigating opportunistic behaviour resulting in less transaction costs (Sorrell, 2005). Kostka & Shin (2013) pointed out "the success of the ESCO model in China depends critically on the formation of trustworthy relationships between ESCOs and potential customers". In the empirical research, interviewees also raised societal trustworthiness several time.

7.2 Future research

This study concentrated on investigating ESCOs' drivers and barriers purely from the economic point of view by using the Transaction Cost Economics theoretical framework. For the future research, the problem can also be approached from different disciplines. For example from the cultural point of view, Hofstede's cultural dimensions such as power distance, uncertainty avoidance and long-term vs. short-term orientations, may shape the decisions between ESCOs and customers.

In this study, we had glanced off the issue that customers may also enjoy other mutually exclusive subsidies than ESCO rewards in energy conservation projects. It would be interesting to investigate deeper the trade-offs in decision-making for project implementation using ESCO contracting or traditional equipment and service purchasing.

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APPENDICES

Appendix A

Variable	4.5.6.2.1 Proposed measures
Potential saving in production cost	• *Expected percentage saving in energy costs (%)* • We expected our contract to lead to a significant reduction in our energy costs
Aggregate production costs	• *Annual energy bill (£k)* • We have sufficient expertise in our organisation to perform energy management efficiently in house
Asset specificity	• The contractor has customised its approach to meet the requirements of our organisation • The projects undertaken by the contractor are unique to our sector • The contractor needed to acquire a lot of information about our organisation to perform this contract • It would be time-consuming and costly for us to switch to another contractor • It would be time-consuming and costly for us to take the relevant activities back in-house
Task complexity	• The services provided by the contract are well defined. • It is straightforward to measure the performance of the contractor • It is straightforward to adjust performance measures for factors outside the contractor's control. • It is straightforward to determine the cost savings achieved by the contract. • Monitoring and verification of the contractor's performance require a great deal of time and effort (reverse coded). • There is a great deal of uncertainty regarding the future demand for these energy services • There is a great deal of uncertainty regarding future needs in terms of technologies for these energy services
Competitivenes s	• There are other companies who could provide us with a comparable service to our present contractor at a competitive price.
Success	• *Percentage saving in energy costs?* Overall level of satisfaction with: • Reducing energy costs • Gaining better control of energy costs • Accessing capital for investment • Transferring risk • Improving the quality and reliability of energy services • Gaining access to up-to-date technology • Gaining access to technical and managerial skills • Replacing ageing equipment • Improving environmental performance • Concentrating attention on the core business

Appendix B

Interview plan

Introduction

During the interview, I would like to discuss about the drivers for and barriers to ESCO. With this topic in mind, I would like first to ask the permission to record our conversation. You and your company will be kept anonymous and confidential at all times. If you are interested, I can send the final report of this study when it is published.

Background

Main questions	Follow-up questions	Specifying questions
What is the size of your company?	What is the number of employees?	How many energy service professionals?
What are your energy efficiency (EE) products and services?	To whom you offer your products and services?	Public or private sectors, industry, building or traffic sectors?
Have you done any ESCO projects using EPC?	If yes, How much, in number and size?	Under the shared savings model or guaranteed saving model?
Are you registered with MOF & NDRC for ESCO-status?	If yes, when? If no, intention to?	

Potential savings in production cost

Opinion questions	Direct questions	Follow-up questions
ESCO is more viable, when the technical potential for production cost savings are large.	What can customers expect from ESCO project?	Significant energy savings, reducing energy costs?

Aggregate production costs

Opinion questions	Direct questions	Follow-up questions
ESCO is more viable, when the aggregate production costs within the customer are small.	Does your company have economies of scale advantage?	

Asset specificity

Opinion questions	Direct questions	Follow-up questions
ESCO is more viable, when the specificity of the assets required is low.	Site specificity: The offering has to be customized for customers?	If yes, do you see this as a barrier?
	Human asset specificity: Need to acquire a lot of knowledge and expertise for projects?	Does your company have sufficient information or need to acquire from outside? Barrier?
	Physical asset specificity: Need to invest in pre-contract energy audits?	By yourself (ESCO) or through third-party? Barrier?

Task complexity

Opinion questions	Direct questions	Follow-up questions
ESCO is more viable, when the difficulty in specifying and monitoring contracts is low.	How complex are the ESCO projects?	Single equipment replacement or entire process or in-between?
	How well can the offering be defined in the contract?	Does your company use the contract model in the "technical rules"?
	Is it straightforward to measure the performance?	If not, do you see this as a barrier?
	Is it straightforward to verify the savings achieved?	If not, do you see this as a barrier?
	Does the monitoring and verification (M&V) require great efforts?	If yes, do you see this as a barrier?

Competitiveness

Opinion questions	Direct questions	Follow-up questions
ESCO is more viable, when the market is competitive.	Are there other ESCOs providing comparable service?	What is the effect of reputation? How does it affects your pricing?
	How competitive is the ESCO market in China?	Do you see this as a barrier or driver?
	Are there high requirement for market entry?	If yes, what? Do you see this as a barrier?
	How do you see the future demand for ESCOs?	If negative, do you see this as a barrier? If positive, do you see this as a driver?

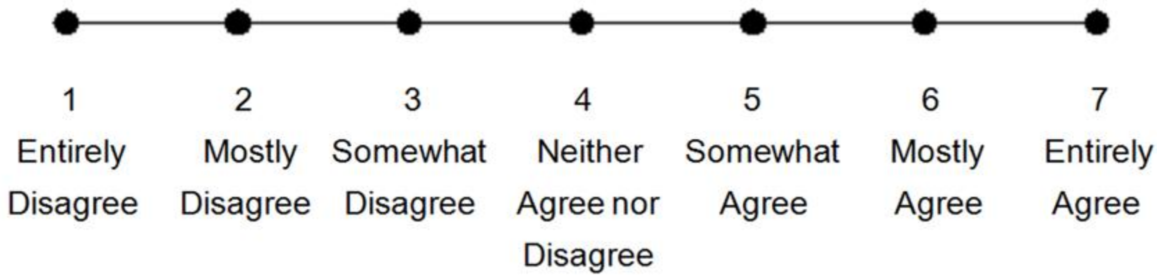
Institutional contexts (Political, Legal, Economic, Financial)

Opinion questions	Direct questions	Follow-up questions
ESCO is more viable, when the relevant institutional contexts are supportive.	Political: What are the governmental policies toward ESCO industry?	Is it supportive or not? Do you see it as driver or barrier?
	Are you aware of the subsidies and tax incentives from government?	Have your company applied them? Do you see them as drivers?
	Legal: How well is the legal enforcement on contract?	
	How well are the contracting standards?	If good, do you see this as a driver?
	How well are the M&V standards?	If bad, do you see this as a barrier?
	How well are the public procurement procedures?	
	Economic: How does external factors (energy prices, financial crisis or economic downturn) in the economic affecting the ESCOs?	Do you see increasing energy price as a driver?
	Financial: Does your company finance the project investment by itself or through third-party financial institutions (FI)?	What are the FIs' policies toward ESCO project funding? If negative, do you see this as a barrier?
	Does your company have sufficient access to capitals?	If no, do you see this as a barrier?

Free discussion

Concluding question
Beside above, what other barriers and drivers you are facing?

Opinion questions are measured on a 7-point Likert scale



Appendix C

Interviewed Chinese ESCOs

Date: 12.03.2013

Interviewee's title: Deputy General Manager

Company A was established in 2010 and is a listed company. Initial registered capital was over 200 million RMB. Company A focuses on the field of waste heat power generation. At the moment, A is one of the companies with most domestic waste heat power generation ESCO projects. Most of A's projects are in the cement and glass industries with mostly large state-owned enterprises as customers. By the end of 2011, company had 17 projects running, 3 under construction and 9 in the planning phase. The turnover was 183 million and profit 52 million RMB in the same year. All of its projects were done under the shared savings model. General project duration was 20 years with breakeven point at 5-6 years. Company was awarded by the EMCA as "China energy conversation service industry annual top brand enterprise" in year 2010 and 2011 and registered with NDRC & MOF in the fourth batch.

Date: 20.03.2013

Interviewees' titles: Northern China Area Manager & Manager Assistant

Company B is a subsidiary of a Group Corporation concentrating on developing and producing non-electric central air conditioning equipment. The company is technology-oriented and serves mainly industry and commercial customers mostly in the private sectors. They use both shared shaving and guaranteed saving models and belongs to the first batch of ESCOs registered with NDRC and MOF.

Date: 26.03.2013

Interviewees' titles: Marketing Director & Senior Engineer

Company C was established in 2006 and is one of the leading building energy saving solutions providers within the energy management systems market. Company provides a wide range of products and professional services within the Building Technology sector. C positions itself as a technology and capital-oriented ESCO. With its 400 employees, the company mainly focuses on the large-scale bundled public building energy efficiency projects with city governments as customers. Company C is one of the first batch ESCOs registered by NDRC and MOF.

Date: 27.03.2013

Interviewees' titles: Deputy General Manager & Senior Engineer

Company D is one of the nine subsidiaries of a Group Corporation, formerly a logistic institution of Chinese military. D has over 900 employees and its own production facilities in two cities. With 10 million RMB registered capital, D is one of the third batch ESCOs registered with NDRC and MOF. The company mainly focuses in providing waste heat and pressure reuse and industry boiler upgrade services. The average return on investment period is three to five years for company's ESCO projects. The customer scope is mainly large state-owned industry enterprises. The company is recently new to EPC mechanism as it was previously mainly an equipment supplier.

Date: 27.03.2013

Interviewees' titles: General Manager & Project Manager

Company E was registered by a group of energy saving environmental protection experts in 2011. The company is a member of EMCA and registered by NDRC and MOF in the third batch. Company consists 20 employees and focuses on providing energy management services for public and commercial buildings. The main products relate to heating and cooling monitoring systems. The company uses both shared and guaranteed savings models in their ESCO projects and project durations vary from one and half to two years.

Date: 29.03.2013

Interviewee's title: Deputy General Manager

Company F is a market-oriented ESCO established in 2012 with 5 million RMB registered capital. F is a subsidiary of a Group Corporation, which has successful operated in Yangtze

River Delta area for over 20 years. Under the Group's strong support, F has large customer base and strong financial advantage. ESCO company is not yet registered with NDRC & MOF.