BARRIERS TO IMPLEMENTING ENERGY PERFORMANCE CONTRACTING (EPC) MECHANISM INTO HOTEL BUILDINGS RETROFIT IN CHINA

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Abstract
Building sector contributes a large part of total energy consumption. Building Energy Efficiency Retrofit (BEER) is an effective approach to save energy & reduce emission of CO_2 and improve sustainability of existing buildings. Energy Performance Contracting (EPC), a market oriented mechanism provided by Energy Service Companies (ESCOs), has been widely used to improve energy efficiency in developed countries. EPC mechanism has been introduced in China since 1990s and implemented in different energy efficiency improvement projects. However, EPC mechanism is still unimplemented in some existing building retrofit projects. This research takes hotel buildings as example aims to identify the barriers to implementation of EPC mechanism into hotel buildings retrofit in China. Qualitative research methodology is employed in this research. In order to identify these barriers, a set of interviews are conducted. After that, a qualitative analysis of feedback information is discussed. Finally, a series of corresponding measures for remove identified barriers are proposed.

Keywords: Energy Performance Contracting, ESCOs, Building energy efficiency

INTRODUCTION

Existing buildings require over 40% of the world's total final energy consumption, and account for 24% of world CO_2 emissions (IEA, 2006). Buildings also represent an important and increasing component of China's energy consumption. For the past 20 years, Building energy consumption in China has been increasing at more than 10% each year. In 2004, building energy consumption alone constituted 20.7% national energy consumption (Jiang and Yang, 2006; Liang et al, 2007). Currently, there are nearly 40 billion m^2 buildings in China and the urban building area is up to 14 billion m^2. 95% existing buildings in China are "highly-energy-consuming". Building Energy Efficiency Retrofit (BEER), such as upgrading to newer, better-performing equipment and building's renovations, is a great way to save on energy bills over the long term. Building Energy Efficiency Retrofit (BEER) supports excellent opportunities to reduce energy consumption in buildings as well as encourages environment protection, rational resources use, and occupants' healthcare.

Although there are many benefits and large potential energy-saving of energy efficiency program in existing buildings, many energy efficiency projects are still unimplemented. The

reasons for delaying projects may vary, most energy efficiency projects stall due to one or a combination of the following perceived barriers (Zobler and Hatcber, 2003): (i) Lack of money, (ii) Lack of time or personnel to design and plan the projects because of other higher priorities, (iii) Lack of internal expertise to implement the projects, (iv) Lack of policy support within the decision making process. Besides above general barriers, there are other special barriers to building energy efficiency retrofit in China: there isn't the energy consumption baseline of different types of buildings in China, which should be established though lots of surveys; the ownership rights of many buildings are not clear; most people have low consciousness to energy efficiency project; new technologies for energy efficiency retrofit should also be further explored (Jia and Zhou, 2008; Yang et al., 2006; Lv and Wu, 2007).

Energy Performance Contracting (EPC) is a market mechanism to deliver energy efficiency projects. EPC mechanism is emerged in US in 1970s and was introduced into China in 1990s (Shen, 2007a). Energy Performance Contracting (EPC) is financing package provided by Energy Service Companies (ESCOs) that include energy savings guarantees and associated design and installation services for energy efficiency projects. EPC mechanism has great advantages for building clients to conduct building energy efficiency retrofit projects and improve sustainability of existing buildings. Energy efficiency projects under EPC mechanism has been widely implemented in nation's industrial, construction, and transportation sectors. However, EPC mechanism is still unimplemented in some existing building retrofit projects. There are significant barriers to implementing EPC success, and these differ by country, sector and other circumstances. This research takes hotel buildings as example aims to identify the barriers to implementation of EPC mechanism into hotel buildings retrofit in China.

ENERGY PERFORMANCE CONTRACTING (EPC) MECHANISM

Energy Performance Contracting (EPC), also known as energy service performance contracting is financing package from Energy Service Companies (ESCOs), which includes energy savings guarantees and associated design and installation services for energy efficiency projects, which was emerged in America in 1970s after the first oil crisis. Energy Performance Contracting is a mechanism for procuring and implementing energy efficiency improvements today that are self-funded over time through guaranteed operational savings. Performance Contracting uses operational savings and avoided capital expenditures to fund repayment of capital for building/infrastructure improvements. However, EPC principle not only is a financing tool, but also a market mechanism. Energy Performance Contract in the ESCO business may be broadly defined as a contract between an ESCO and its client, involving an energy efficiency investment in the client's facilities, the performance of which is somehow guaranteed by the ESCO, with financial consequences for the ESCO (Taylor et al, 2007). Under an energy performance contract, the ESCO will provide financing for a specified set of energy efficiency retrofit measures, along with associated design, engineering, and installation services, the owner or user can achieve high energy efficient facilities and get potential savings with little or even no front investment. The Basic concept of energy performance contracting is shown in Figure 1. The first bar represents the total utility costs of one facility before performance contract. In the second bar, after retrofitting the energy savings are shared by client and ESCO during performance contract period. After performance contract, all the cost savings belong to client after the performance contract period, shows in the third bar.

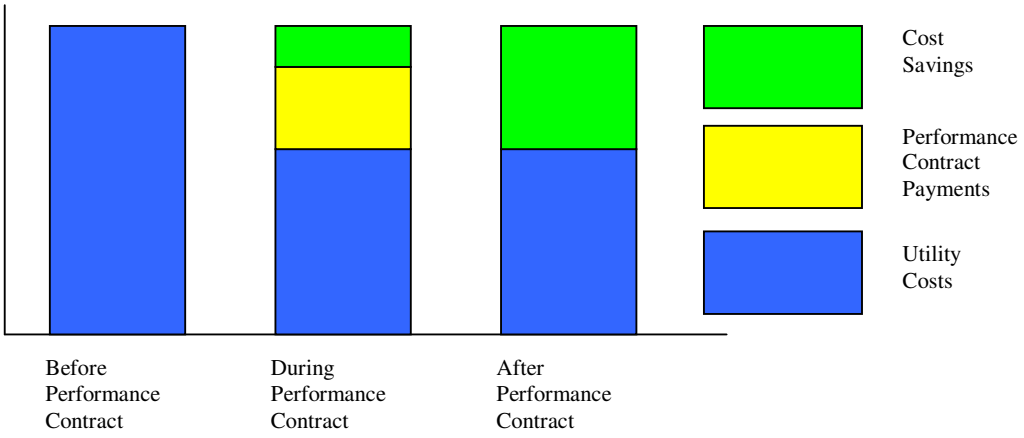

Figure1 *Basic Concept of Energy Performance Contract*

EPC was introduced to China in 1996 in partnership with World Bank and Global Environment Fund, The program aims to introduce EPC, improve energy efficiency, reduce greenhouse gas emissions, and protect global environment in China. The program is divided into two phases (Shen, 2007a). During Phase I (from 1998 to June 2003), three pilot energy service companies (ESCOs, also called energy management companies in China-EMCs or EMCOs) were created: Beijing ESCO, Liaoning ESCO, and Shandong ESCO. They altogether have established client-provider relationships with 405 users, implemented 475 projects, and invested 1.33 billion RMB. The project has brought in both energy conservation and environmental benefits: capacity of an annual energy saving of 1.49 million tce plus capacity of an annual carbon dioxide reduction of 1.45 million ton-c. Phase II refers to the period of 2003-2008. The objective of Phase II is to promote the adoption of EPC energy saving mechanism, foster and develop energy conservation service industry, expand investment in energy efficiency projects, and reduce carbon dioxide emissions and other pollution. Phase II includes two subprojects: 1) A Loan Guarantee Special Fund was established to help EMCo secure loans from commercial banks to implement energy efficiency projects. 2) The Energy Management Company Association (EMCA) was created in April 2004 to facilitate the operation of EPC and development of energy conservation industry in China (Shen, 2007a). Investment in energy conservation projects using energy performance contracting in 2007 up to over USD 1 billion was four times the 2005 level. Meanwhile, EMCA members increased from 59 to 308 (including 185 ESCOs) in the end of 2007 and implemented many energy conservation projects in the nation's industrial, construction, and transportation sectors (Taylor, 2009).

There are many ways to structure an EPC model. Two common EPC models are shared savings contract and guaranteed savings contract (Rezessy, et al; Han, et al. 2006; Bertoldi and Rezessy, 2005; Hui, 2002; Hansen 2003, Poole and Stoner 2003). The shared savings contract means the ESCO designs, finances and implements the project, verifies energy savings and shares an agreed percentage of the actual energy savings over a fixed period with the customer. This is also referred to as the "Full-Service ESCO". In guaranteed savings contract, the ESCO designs and implements the project but does not finance it, although it may arrange for or facilitate financing. The ESCO guarantees that the energy savings will be sufficient to cover debt service payments (Bertoldi and Rezessy, 2005; Hui, 2002; Hansen

2003). Besides the two main models, various models of EPC process have been implemented according to energy efficiency projects in different areas. The general process of EPC mechanism may be similar, which is comprised of three phases: Phase I Selecting contractor; Phase II Make an EPC agreement; Phase III Implementing EPC agreement. The common process can further be divided into the follow seven steps: Identify Project; Planning assessment; Select a contractor; Project design; Arrange financing; Negotiate EPC Contract; Construction and Implementation; and Measurement and Verification of Savings.

EXISTING RESEARCH ON BARRIERS TO EPC/ESCO

Despite the business concept of EPC is very attractive from a theoretical perspective, there are many barriers to EPC mechanism and ESCO industry. Vine (2005) made an international survey of barriers to ESCO industry faced in different countries, and listed the key barriers to EPC from end user aspect, which include: Financing, Perception of risk, Information/awareness/knowledge, EPC expertise, Access to energy-efficiency equipment and technology, Administrative, Reliability, and Credibility/confidence/ trust etc. Painuly et al. (2003) classified the barriers to ESCOs growth in developing countries into three categories: market barriers, institutional barriers and financial barriers. In developed countries, European Commission's Energy Service Company in Europe (Status report 2005) and the International Energy Association's Demand-Side Management Implementing Agreement's Task X identified some major barriers: lack of information and understanding of the opportunities that energy efficiency offer; lack of culture for project financing; public procurement rules that prevent the use of ESCOs; "low" price of electricity; safety and reliability concerns that hinder the introduction of new technologies; burdensome administrative procedures that allow only very large projects to be carried out; limited understanding of energy efficiency and performance contracting by financial institutions; administrative hurdles persist; limited government support; lack of motivation; and Measurement and verification protocols for assuring performance guarantees are not understood(Westling, 2003; Bertoldi and Rezessy 2005).

The development of EPC is later in China. China is a large developing country. Many barriers encountered in the development of EPC industry in China are discussed in previous studies (Fu, 1999; Wang, 2009; Yang et al, 2004; Xie, 2008; Shen, 2007; Wang, 2008; Zhang, 2008). Table 1 summarizes barriers to EPC in China.

Table 1: *Barriers to EPC in China*

Barriers	**Sources**
Information/awareness	Wang (2009), Fu (1999), Yang et al (2004), Xie (2008)
Financing	Wang (2009), Yang et al (2004), Xie (2008), Shen (2007b), Wang (2008), Zhang (2008)
Measurement/verification	Yang et al (2004), Wang (2009), Zhang (2008)
Institutional barriers	Wang (2009), Fu (1999), Yang et al (2004), Xie (2008), Shen (2007b), Wang (2008), Zhang (2008)
Risk	Yang et al (2004), Xie (2008)
Credibility/trust	Shen (2007b), Yang et al (2004), Zhang (2008)
EPC expertise	Yang et al (2004)

Previous researches, both in developed and developing country, mainly focus on barriers to the EPC/ESCO industry development. This research wants to pay more attention to explore barriers to implementing the EPC mechanism at project level. The following parts of this paper describe a qualitative research on barriers to implementing EPC into hotel buildings sectors.

EXPERT INTERVIEW

Above section has summarized barriers to EPC industry development. In order to explore barriers to implementing EPC in hotel retrofit projects, a series of semi-structured interviews with the industry practitioners have been carried out. The interviews involved talking to project managers, managers of engineering department in hotels, executives of hotels, contractors (ESCOs), and researchers. Altogether 15 interviewees were conducted. The details of the interviewees are shown in Table 2.

Table 2: *Details of the interviewees*

Sector	**Personnel interviewed**	**No. of interviews**
Hotel	**Manager of engineering department in hotels:** *South Union Hotel (H1)* *Golden Coast Lawton Hotel(H2)* *Haikou Huitong Hotel(H3)* *Ye Hai Hotel(H4)* *Haikou Tower Hotel(H5)* *Leaguer Resort Sanya Bay(H6)* *Xinyuan Hot Spring Hotel(H7)* *Sanya Beautiful Spring Spa Garden Resort(H8)*	8
	Executive manager of hotel: *Bohua Harbour View Hotel(H9)*	1
ESCO	**Project manager of energy service companies:** *Bard Energy Saving Engineering Ltd.(E1)* *Yangpu Oasis Energy Saving Ltd. (E1)* *Shenzhen Guoneng Power Investment Company(E1)*	3
Academics	**Researchers in sustainable construction and green building***(A1-A3)*	3

Because the interviewees were senior personnel, the interviews were not purposefully structured to facilitate free flow of ideas. At beginning of interview, I explained this framework to each expert in detail. Then the interviews were discussed around 5 issues: 1) Understanding of Energy Performance Contracting mechanism, 2) Difficulties to implement EPC mechanism, 3) Why do clients use or not use the EPC mechanism? 4) Problems in EPC process, 5) How to clear barriers mentioned above? Questions were open and interviewees

were encouraged to add any details that they considered relevant. The interviews were conducted between April and July 2010. They lasted from 1 to 2 hours and were taped and fully transcribed.

RESULT AND FINDINGS

All the barriers mentioned above are discussed by experts during interviews. This research focuses on hotel sectors. Most important barriers and special barriers for this type of project are discussed as follows:

Hotel leader's awareness

From above review, customers, suppliers, engineering companies, banks, finance sector, industry lack awareness and information of EPC. According to collected information from interviews, most leaders of hotel have willingness to reduce energy consumption. However, only few of them have heard about EPC.

> *I never heard about the EPC (H6, H8).*
> *I know about the EPC, I think it is another method for sales promotion of energy-saving production (H4).*

Hotel managers' lack of understanding and interest in EPC is a barrier to implementing EPC in hotel retrofit.

> *I think clients' awareness to EPC should be improved, they don't believe we can provide a win-win retrofit plan based on EPC mechanism (E1).*

Measurement and Verification (M&V)

Measurement and Verification (M&V) is one of most important part of EPC procedure, which is to identify the project result and energy savings. There is not a standard guideline to do this job in China. Sometimes hotel clients and contractors couldn't reach an agreement on how to measure project energy savings because of lack of measurement equipment and baseline data in hotel industry.

> *We had made a success retrofit in last year, I think it very important to identify the energy consumption baseline before conduct the retrofit (H2).*
> *It is very difficult to measure the energy saving accurately. Energy consumption is impacted by many factors, such as working hours of equipment, weather, and others (H7).*

Credit/trust

Both experts from hotels and ESCOs worried about their partners' credit. There is still lack of credit history for ESCOs and customers in China. This will impact project financing from the third party institute. Lack of credit and trust during project organization even causes project failure. Because there is not a standard for M&V, it is also difficult to agree with each other about the result of energy saving, if they don't trust each other.

> *ESCOs like to get up to tricks on M&V. Maybe big contractors certified by National Development and Reform Commission are much better (H3).*

Qualified staff and equipment
Shortage of qualified staff for ESCOs and hotels is another barrier mentioned by experts.

> *As contractors, ESCOs should give a technical support during the retrofit projects, however, sometimes I found the skill of their workers is worse than ours' (H3).*

Besides, some poor quality equipment is used in retrofit projects, which cause these projects failure.

> *……equipment quality cannot meet the preliminary requirement, there is a phenomenon called "saving energy but not saving money" because of short life of poor quality equipments (H1).*

Small scale
Two experts from ESCOs indicated their companies consider prefer industry retrofit projects rather than hotel retrofit projects. Because hotel retrofits projects are usually small with high relative transaction costs. In China, governments have provided many funding supports for energy efficiency projects. Also because of small scale of these projects, these projects cannot reach the requirement of support policies.

> *To be honest, the business of our hotel is not good. It is tight budget for us to update our energy consumption system. I have studied the support polices to these projects. Because of small scale of these projects, we cannot meet the requirement for getting a support funding from government (H7).*

Have sufficient fund
Some hotels have sufficient funds to implement energy efficiency upgrades themselves. They don't want to hire an expensive adviser and be bound to running a multi-year service contract. This will impede ESCOs to enter this market.

> *As a manager, I pay more attention to the operating performance of hotel. Benefit from energy saving affect little to the operating performance. Investment needed in energy efficiency retrofit takes up a small part of total operating cost. In our hotel, we prefer to conduct retrofit ourselves rather than contracting with an EPC contractor (H1).*

Operation status
Experts from ESCOs worried about the future operation status of hotel. Performance contract is a long term service contract. ESCOs invest project and get payback from future saving. Bad operation status of hotel is big risk for ESCOs.

> *Another risk for me is the operation status of hotel. If the business of the hotel is not good, the operating hours of equipment I supplied will be shorten. The energy saving and benefit share is calculated based on the operating hours. So the payback period will be longer (E1).*

> *We don't consider hotels with bad operating status. You know EPC is a long term contract. If the hotel is bankrupt during the contract period, we cannot get back our investment (E3).*

Above 7 barriers to EPC in hotel retrofit are most usually cited by interviewees. Besides these 7 barriers, other barriers such as financing, risk, and institutional barriers and so on are also

mentioned by experts. These barriers are commonly for development of EPC industry and have been discussed by previous research. This research focuses on barriers to hotel retrofit projects, the common barriers will not be discussed detail in this study. Having identified the barriers to hotel retrofit, so what are the possible solutions or recommendations to eliminate the barriers? Some suggestions we obtained during the interviews are given in Table 3.

Table 3: *Suggested solutions to the barriers*

Barriers	**Possible solutions**
Leader's awareness	Information and demonstration programs, training, education programs
M&V	Accurate measurement technology and equipment, M&V protocols
Credit	Accreditation system, standardization of contract procedures
Qualified staff and equipment	Education programs, training, quality regulation
Small scale	Reduce transaction costs, policy incentive
Have sufficient fund	Information and demonstration programs, education programs
Operation status	Fast payback retrofit measures, contract strain

CONCLUSIONS

This research aims to explore barriers to implementing EPC mechanism into hotel buildings retrofit in China. This research reviewed EPC mechanisms, and current existing research in this topic. After that, 15 expert interviews were conducted. This resulted in the barriers to EPC in hotel retrofit. The interviews further resulted in solutions to clears the identified barriers.

Seven barriers to EPC in hotel retrofit are summarised based on information collected from interviews. These are Hotel leader's awareness, M&V, Credit, Qualified staff and equipment, Small scale, Have sufficient fund, and Operation status. In order to clear the encounter barriers, some solutions are suggested as follow: education program, information and demonstration programs, training, policy incentive, accreditation system, standardization of contract procedures, and so on. The findings in this research are collected based on hotel buildings retrofit. Implementation of EPC mechanism in other type of energy efficiency projects should be also explored in future research.

ACKNOWLEDGEMENTS

This paper is support by research fund provided by The Hong Kong Polytechnic University. The authors are thankful to all those who contribute in the interviews.

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