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Managing energy efficiency of buildings in China: A survey of energy performance contracting (EPC) in building sector

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ABSTRACT

This paper reports on a nationwide field survey of managing energy efficiency of buildings under energy performance contracting (EPC) in Chinese building sector. The survey aims at getting insight of Chinese experiences of EPC and survey yielded information on profile, specificity and risk specifications of EPC in Chinese building sector. The key findings are that the existing EPC projects are mainly driven by policies and majority of first parties in EPC are owners of public buildings. The contract specificity is worryingly low, with underspecification prominent in the contract sections of renewal and change of the planned solutions, dispute resolution and compensation for personal and property damage. Insufficient risk specification was a major cause of contract failure and disputing. High risks are observed in not enough feasibility study, delay in completion, operational risks, delay in payment and uninsured loss. Most post EPC projects would be worryingly unsuccessful, given to the facts that many of them have not established their energy team, have no further investment and have no effective maintenance. The Chinese existing emission trading scheme (ETS) offers a vital opportunity for upscaling EPC in building sector and policy framing is needed for linking EPC projects and ETS.

1. Introduction

China's unprecedented socio-economic growth drives expansion in building sector, which has added about 2 billion m^2 annually over the last decades. Meanwhile, building energy consumption has increased by 40% since 1990 (Yu et al., 2012). The building sector accounts for about 30% of the final energy consumption in China and consumes enormous resources, e.g. 40% of world steel consumption. This development has not gone unnoticed and translates into the serious risk of China locking itself in with a large energy-inefficient housing stock. This realization has brought low energy housing onto the national agenda and into the 12th and 13th Five Year Plans (FYP). Thus, the building sector plays a vital role in China's pursuit of a more energy and resource efficient and low carbon pathway. China faces a great challenging task in improving energy performance in building sector for achieving its CO_2 target in 2020. Over the last decade, the Chinese government has promoted energy efficiency building practices. Its first green building standard was issued in 2006. Since then the government formulated several key policy documents to accelerate the development of green buildings, including energy retrofit of existing buildings in China. By 2020, the Chinese government aims at 50% of new constructions to reach green building standard. It is estimated that only 10% of new construction projects currently reach that standard. Of those 10% about 90% are located in the developed eastern China. It is estimated that annual market for energy saving in Chinese building sector is about 400 billion Chinese Yuan and it is still increasing by 15% annually (The State Council of China P.R, 2013).

In energy saving, China favours EPC that was started in 1970s in Western countries. China's EPC experience, started in 1996, is of both scientific and practical interest (Liu and Lei, 2009; Yuan et al., 2011; Lv and Wang, 2011). China's EPC is applied mainly in the sectors of energy-intensive industries, buildings and transportations (Zhang et al., 2011; Lin, 2012). China's later experiments were motived by the purported superior efficiency of energy service companies (ESCO), the advantage of energy efficiency service provision unhindered by cumbersome government bureaucracy and access to private finance (Sorrell, 2007; Larsen et al., 2012). Many experimental EPC projects foundered amidst disputes and contract renegotiations that arose from performance problems, limited profits in building sectors and incomplete contract documents (Vine, 2005; Goldman et al., 2005). Marino et al. (2011) have made a survey and concluded that, as of 2010, the energy service market in Europe is still far from utilising its

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full potential. Wide-scale peer-reviewed studies investigating the development and up-to-date status of the European ESCO market are scarce. Painuly et al. (2003) have concluded that ESCOs are in nascent stage in many developing countries and face several barriers that include market, finance and institutional barriers, poor energy pricing policies, high transaction costs etc. The International Energy Association's Demand-Side Management Implementing Agreement's Task X identified some major barriers of ESCO development: 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; and limited understanding of energy efficiency and performance contracting by financial institutions (Westling, 2003a, 2003b). These barriers are consistent with the types of barriers reported in the literature on ESCOs worldwide (Bertoldi et al., 2003). Unlike fast EPC development in Chinese industrial sectors (e.g. power generation, cement industry, energy-intensive manufacturing industries), EPC development in Chinese building sector is encountering challenges of lack of financing, small scale of energy efficiency projects (many energy-efficiency projects and ventures in building sector are too small to attract the attention of large multilateral financial institutions), public procurement rules that prevent the use of ESCOs, low price of electricity and Lack of government support for energy performance contracting, especially in building sector where local banks and private investors are reluctant to participate (Xu et al., 2015). 21 successful factors of adopting EPC in Chinese building sector have been identified, covering six clusters of project organization process, EPC project financing for hotel retrofit, knowledge and innovation of EPC, sustainable development and monitoring & verification (M&V), implementation of sustainable development strategy, contractual arrangement, and external economic environment (Xu et al., 2011). There have been limited studies and literatures examining the current level of ESCO activities and EPC development in Chinese building sector.

This article reports on a nationwide survey of EPC in China's building sector. Its aim is to assess the existing situations of EPC and whether EPC can help China mobolising great potentials of energy saving in building sector, in particular in the context of Chinese nationwide emission trading scheme (ETS). Drawing on the survey data, this article constructs a profile of Chinese EPC in building sector and examines what drivers China to scale up EPC from its first generation to next one in building sector. Specifically this paper addresses the following issues:

1) The profile of EPC projects in Chinese building sector, including contracting and financial features, main measures installed by ESCO;
2) What are the existing main driving forces for the development of EPC in China's building sector;
3) What are the generic and risk specificity of EPC projects in China's building sector;
4) Whether China's CO_2 emission trading scheme could become a vital driving force for upscaling EPC in building sector; and
5) What are the performance of post-EPC projects in China's building sector.

2. Methods: the EPC survey in China's building sector

The survey method and data sources are threefold: (1) "top-down" pre-coded questionnaire survey; (2) "bottom-up" analysis of project-level information on EPC contracts and (3) in-site visits to post EPC projects. Survey of this study is significantly supported by China Association of Building Energy Efficiency (CABEE) that has collected EPC projects in Chinese building sectors. We identified initially 272 ongoing EPC projects and 12 completed EPC projects from CABEE's EPC project database. Those 272 ongoing EPC projects are from different climatic zones of China and are from different regions of economic scale of China. Thus those 272 EPC projects have good representativeness of both climatic zones and economic scales. Given to the fact that EPC in China's building sector is still in its infancy, numbers of completed EPC projects are limited and only 12 completed EPC projects are selected for in-site visits. Among the 272 on-going EPC projects, 248 are responded with the response rate of 91.2%. From the 248 on-going EPC projects, we conducted a willingness-interview with their senior managements to ask them whether they are willing to share their EPC contract documents with us. We got 42 positive replies and most of the 248 on-going EPC projects (83.1%) are not willing to share their contract documents even we have promised to sign a confidential agreements. Among the pre-selected 12 completed EPC projects, 8 accepted to receive our visits and 4 refused to accept us, due to various reasons of senior management short leaving, lack of responsible persons and no time.

The survey was carried out in the period of June–December 2016. The pre-coded questionnaire is gleaning information from both buildings owners and ESCOs on EPC driving forces, barriers, existing performance of contracts, main measures installed, types of contractual arrangements, revenues obtained from various types of technologies (e.g., energy efficiency, renewable energy, and onsite generation projects) and services (e.g., consulting, master planning), and their views on trends in project installation costs, payback times, and operation and maintenance (O&M), savings and policy framing. Copies of Relevant documents of 42 operational EPC projects are obtained and reviewed and telephone interviews to relevant source persons (e.g. in-site managers of ESCOs, managers of building owners, etc.) are conducted for the purpose of analyzing key factors of EPC projects, in particular performance of contract, payment issues, cooperation between ESCOs and building owners and improvement of energy efficiency due to the EPC projects. Visits to 8 post EPC projects are conducted for getting insight of energy performance of buildings after completion of EPC projects. Before the surveys, literature study is conducted for getting the information of EPC in building sectors, as compared to EPC in other industrial sectors.

For evaluating power of policies on stimulating EPC development, Chinese EPC policies at both national and local levels have been reviewed and three types of policies have been clarified. Those three types of EPC policies are stricter regulation and compulsory standard for energy efficiency of buildings, energy saving subsidies provided by both national and local governments and tax reduction for ESCO. All 248 EPC projects are invited to give a score of 0–10 to each of the three types of policies, and low score means less powerful and high score means powerful. Scores obtained from all 248 EPC projects were subsequently added. This yielded an aggregate score for each of the policy types with a range of zero (no powerful) to 10 (most powerful).

For ensuring quality and reliability of the data collected, all data submitted by the EPC projects are reviewed by members of an accreditation committee that is established by this study, which includes interviews and telephone-checking with a sample of customers to verify EPC project information submitted and allow EPC projects to provide feedback on the survey results and findings.

There are several caveats to this study. First, CABEE's database on EPC projects in building sector is voluntary-based and thus projects collected by this database may not cover all EPC projects of building sectors. Thus some best practices and samples may be missed in this study. Second, all surveys conducted by this study are EPC project based. All replies we received are sometimes from ESCO, and sometimes from building owners and in most cases are from combinations of ESCO and building owners. Comments from ESCO may differ to that of building owners. Third, a larger sample would have given us more confidence in generating findings. Unfortunately, a lack of resources did not allow for a larger sample.