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Opportunities and Challenges of Energy Performance Contracting to Improve Existing Buildings in Hong Kong

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SUMMARY

Energy performance contracting is a financing technique that raises money for investments in energy efficiency that is based on future savings. It enables money that will be saved as a result of introducing a new energy-efficient measure to be used to offset the cost of financing, installing and operating that measure. In recent years, the technique was being introduced and implemented in some buildings in Hong Kong. Although it has the potential to help reduce energy costs and improve existing facilities, the take-on rate remains low at present.

This paper explains the basic concepts of energy performance contracting and discusses the opportunities and challenges of it to improve the performance of existing buildings in Hong Kong. The key factors and market potential for developing the EPC technique are described. The barriers and challenges affecting its development are examined. It is found that Hong Kong has good opportunities for applying energy performance contracting but some market and institutional barriers are limiting its application at present. The important considerations for implementing the technique are discussed.

Keywords: Energy performance contracting, energy services companies, building energy efficiency, Hong Kong.

1. INTRODUCTION

Energy performance contracting (EPC), also known as energy savings performance contracting, is a financing technique that raises money for investments in energy efficiency that is based on future savings [1, 2, 3]. It enables money that will be saved as a result of introducing a new energy-efficient measure to be used to offset the cost of financing, installing and operating that measure. By definition, the future savings must be greater than the costs. This technique, normally offered by energy services companies (ESCO), allows the capture of benefits from energy savings without upfront capital expenses on the part of the client or building owners [4, 5]. Figure 1 shows the basic concept of EPC. In the global market, the EPC or ESCO industry is becoming an important trend in many countries such as USA and Japan [6, 7, 8] because it can offer opportunities to improve the energy and environmental performance of buildings and industrial facilities.

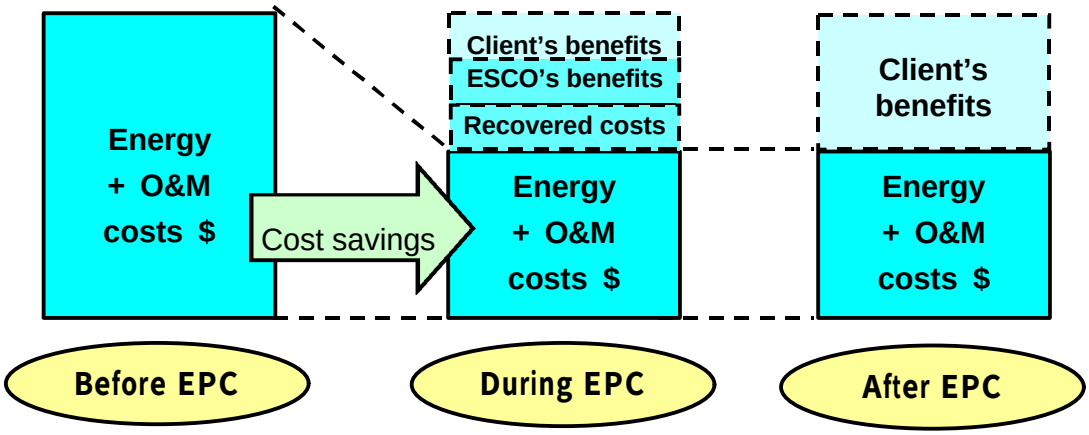

Figure 1. Basic concept of energy performance contracting (EPC)

In recent years, the EPC technique was being introduced and implemented in some buildings in Hong Kong. People believe it has the potential to help reduce energy costs and improve existing facilities so that 'sustainable' building performance can be achieved. However, the take-on rate of EPC in the local building industry remains low at present and there is a lack of understanding and professional skills about how to apply the technique effectively.

This paper explains the basic concepts of EPC/ESCO and discusses the opportunities and challenges of EPC to improve the performance of existing buildings in Hong Kong. The key factors and market potential for developing the EPC technique are described. The barriers and challenges affecting its development are examined. The important considerations for implementing the EPC are then discussed.

2. ENERGY PERFORMANCE CONTRACTING

In general, a 'performance contract' is a contract with payments based in performance [2]. In addition to energy conservation projects, performance contracts can also be used to mitigate indoor air quality concerns, to reduce water and sewer usage, or to implement more complex measures such as renewable energy systems. The benefits of a performance contract for a business include:

- Reduced risk - the contractor guarantees and takes on the risk of not achieving savings
- Turnkey services - the performance contractor provides all required services (for example, to do all necessary energy audits and retrofit)
- The business or institution needs less internal expertise
- Project financing can be 'off balance sheet' and not affect debt load
- State-of-the-art products and services can be used
- Savings can be much higher than if the business or institution carries the work itself
- Additional improvements to environmental performance can be paid for out of the savings.

EPC uses cost savings from reduced energy consumption to repay the cost of installing energy conservation measures. The costs of the energy improvements are borne by the performance contractor and paid back out of the energy savings. The energy conservation measures may include fuel saving measures, water efficiency measures, load shifting and energy reductions through installation or retrofit of equipment, and/or modification of operating procedures.

When a client enter into an EPC agreement, the ESCO will identify and evaluate energy-saving opportunities and then recommend a package of improvements to be paid for through savings. The ESCO will provide engineering services from design, to equipment specifications, to equipment ordering and installation, to management of the construction, and so on. It will guarantee that savings meet or exceed annual payments to cover all project costs, usually over a contract term of 4 to 10 years. If savings don't materialise, the ESCO will pay the difference. To ensure savings, the ESCO often offers staff training as well as long-term energy management and maintenance services to the client. Typically, the recommendations from the ESCO might include replacing lighting equipment, modifying or replacing chillers and boilers, installing modern energy management control systems, replacing motors or even installing pool covers or more efficient kitchen equipment.

There are different ways of structuring a performance contract [4]. The most common is 'guaranteed savings', in which all the contractor's costs (equipment, installation, mark-up, fees and so on) are repaid annually out of the savings as they accrue. The length of the contract (typically 4 to 8 years) is usually chosen so that all costs are paid for by the end of the contract period. This method allows the addition of extra measures as the contract progresses, with the increased savings covering the higher costs.

The second type of contract is known as 'shared savings'. In this arrangement, the client and the ESCO agree to share the savings over the contract period according to an agreed formula. The actual cost of the measures is not included in the contract, and the client has no obligation to pay off those costs. In return, the ESCO does not guarantee the savings. Contract terms are usually longer (up to 10 years) because it takes longer for the investment to be recovered, and the risks to the ESCO are higher. A variation of shared savings is 'pay from savings' which operates more like a loan and is commonly used in Canada.

The third type is the '*chauffage*' (French, means heating) or full energy/environmental services contract. Here, the ESCO effectively takes over the operation of a customer's utility or production facilities as well as upgrading them, and often pays the customer's utility bills as well. The client pays the contractor a regular fee equal to the utility bills before the project or some other negotiated fee. This arrangement is generally found in Europe, where the complete management of a building or facility by a contracted third party is more common.

3. OPPORTUNITIES IN HONG KONG

In Hong Kong, with the economy downturn in the past few years, energy cost is becoming an important concern for building owners and developers. The potential energy and cost savings in existing buildings are very large since there is a vast stock of existing buildings and many of them have been in use for ten or more years. Figure 2 shows the total floor area of building newly completed in 1968-2000 in Hong Kong [9] and it is broadly divided into three categories: 'residential', 'non-residential' and 'combined residential & non-residential'. In 1977-1992 (about 10 to 25 years from now), there are about 47.8 million sq.m total floor area produced and this represents 57.8% of the sum for 1968-2000. In terms of building type, for 1977-1992, there are 7.8 million sq.m residential, 26.1 million sq.m non-residential and 14.5 million sq.m combined residential & non-residential. It can be seen that commercial floor space is playing a significant role in the existing building stock and they could be a critical market for the EPC or ESCO industry.

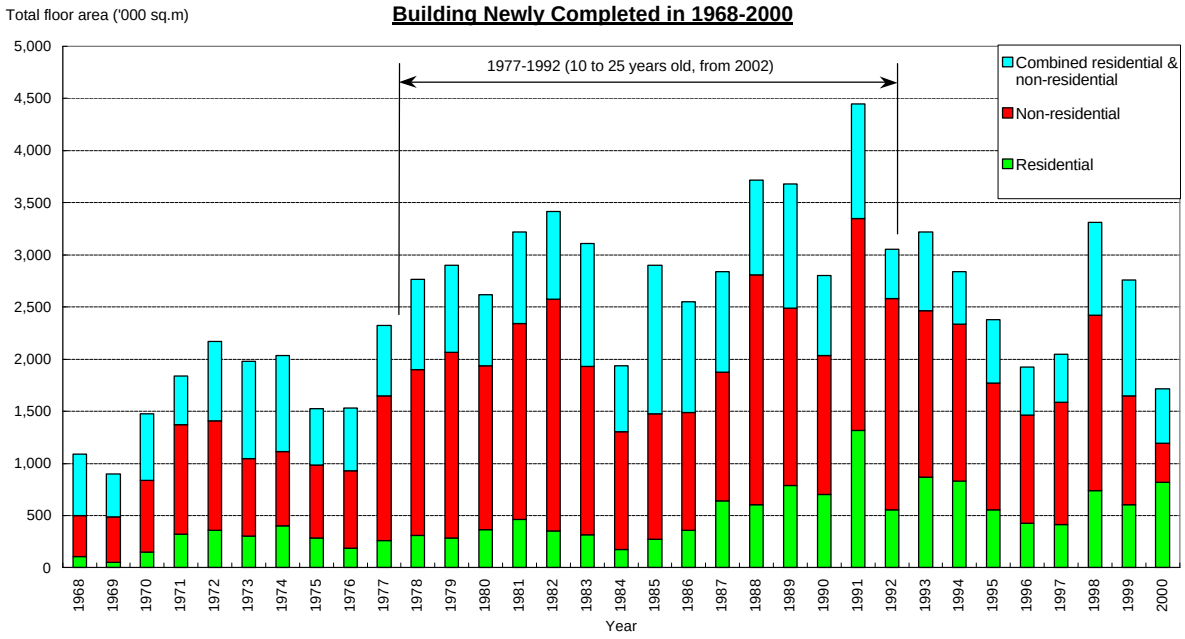

Figure 2. Building completed in 1968-2000 in Hong Kong

It has been suggested by Li [10] that the potential ESCO market in Hong Kong is around US$100 million and the large energy consumers are good EPC candidates. In practice, the ESCO prefers owner-occupied or single-tenant buildings, such as hospitals, hotels and universities. Air-conditioning and lighting systems are usually the major areas for installing energy conservation measures, since these systems dominate the energy consumption in large commercial buildings. For example, Deng and Burnett [11] found out that in Hong Kong's hotel buildings, one-third of total energy was used for air conditioning.

There are a lot of opportunities for achieving energy and cost savings in the existing buildings. For instance, Lee, *et al.* [12] pointed out that oversized equipment is one of the key factors for poor energy performance of commercial buildings in Hong Kong. If an investigation of the building and its equipment can be done systematically through the use of EPC technique, then significant savings can be obtained from optimisation of the equipment or building system.

More and more building owners and developers are interested in EPC. The technique is particularly useful for situations where capital investment budgets for energy efficiency retrofits is difficult to obtain. Potential EPC customers often prefer to work with an experienced and reputable ESCO for a guaranteed energy saving programme. Currently, there are a number of active players in the local ESCO industry, including automatic control companies, building services consultants/contractors, Hong Kong Productivity Council (HKPC) and the power companies. As the EPC opportunity for government buildings is huge, the Electrical and Mechanical Services Department (EMSD) has carried out energy audits and started to provide energy efficiency programmes to the related organisations like the Hong Kong Police Force. With EMSD's transition to a business operation through a trading fund policy, it is possible that EMSD may eventually become an ESCO or EPC provider.

The HKPC is building strategic alliances with local power companies to promote EPC. With the development of de-regulation policy in Hong Kong, the power companies are trying to enhance their service and competitiveness, for example, by subsidizing the replacement of gas boiler by electricity boiler. They promote EPC and also put it as a measure for demand side

management (DSM) and environmental protection. Experience from other countries indicates that utilities can enter and play an important role in the EPC market [6, 7].

To assess the development potential of the EPC market, it is crucial to consider wider policy issues and regional development trends. In recent years, the Hong Kong Government is putting a greater focus on energy efficiency and environmental impact. A number of policy tools and programmes have been implemented [13]. Some of them will create opportunities for EPC and energy retrofits. For example, the Government is planning to widen application of the more energy efficient water-cooled air-conditioning systems in buildings [14]. At present, 28 areas in Hong Kong have been identified in a pilot scheme. Consideration is given to the development of centralised district cooling systems using seawater for once-through condenser cooling. Another option is to allow city water to be used for make-up of water losses at cooling towers. By doing this, buildings that are restricted to using air-cooled air-conditioning systems may adopt or convert to water-cooled systems.

Hui [13] pointed out that the development of building energy codes in Hong Kong and Mainland China has significant impact on the work for energy efficiency improvement. With increasing awareness and growing concern for energy efficiency, this might open up a huge market and create much business opportunities for the ESCO industry. The results will be very important for ensuring sustainable energy development in our region.

4. BARRIERS AND CHALLENGES

Although the potential of applying EPC is large, some market and institutional barriers are limiting its development. The major barriers are explained below.

- *Weak awareness and experience*. As the ESCO industry is still developing in Hong Kong and many people (like building owners, bank officers, contractors, lawyers) are not familiar with EPC and its financing method, it is difficult to convince customers, develop performance contracts and arrange the financing.
- *Complex legal and contractual issues*. Performance contracts are unique documents, based on fairly complex transactions, including the methods of contract performance and the methodology for measuring savings and calculating payments. The ESCO and potential customer often find it difficult to decide the contract terms and understand the duties, obligations and risk allocation.
- *Problems with conventional procurement processes*. EPC requires a different approach from conventional contract and tendering procedures. For example, the particular specifications often cannot be specified but opened to different ESCO for different saving strategies and the contract period will depend on the financial investment strategy. The current procurement processes and financial controls, such as the accounting system in government projects, will hinder the adoption of EPC.
- *Problems with measurement and verification*. The measurement and verification (M&V) method must be agreed before entering into EPC. Reasonable changes or adjustments should also be allowed since things may change over years. The complexity of estimating building energy performance and the lack of commonly accepted standards for measuring energy saving have impeded the application of EPC.

The challenges facing the local ESCO industry are similar to those in other countries. An ESCO must have the technical, business, financial and management skills necessary to carry

out a turnkey project. Both customer and the ESCO must have a partnership. Customer must not view the ESCO as someone to grab some quick money and go away; ESCO must pursuit further savings for the customer after site taken [10]. It is to the mutual benefit of both parties to begin the process with a good understanding of exactly what the goals of the project are. Roosa [15] has outlined the five project stages in the development of performance contracts.

- Stage 1: The opportunity assessment
- Stage 2: Preliminary energy services program
- Stage 3: Development of the detailed proposal
- Stage 4: Project implementation
- Stage 5: Performance assurance and measurement & verification services

The EPC process requires technical knowledge and various management skills, as well as thorough understanding of the building's characteristics. There is a need to develop the relevant skills and adapt the general principles of EPC to suit the local context and practices. In any performance contract, the contractor takes on the risk of the expected savings not being achieved. Factors that would affect the savings such as climatic conditions or changes in building occupancy or use are considered in the contract. Other factors, such as insolvency of the energy user or non-payment of fees, are problems faced by the ESCO. Risk can be diminished in several ways, including the use of due diligence when assessing the project.

From the client's viewpoint, Hansen [16] recommended that an organisation should first assess its energy conditions and then determine the best outsourcing strategies for EPC. If EPC is to be used, they should have reasonable knowledge of expected major capital expansions, and changes in ownership, facility use and occupancy that are likely to occur over the life of the contract. They should also have internal technical, legal and managerial capability to understand EPC and to work with an ESCO.

5. IMPORTANT CONSIDERATIONS

5.1 Choosing a Contractor

Getting the right ESCO is an important consideration for the customer. In general, companies offering performance contracting services include:

- *Equipment suppliers*. EPC services are normally offered by an independent branch of companies such as industrial control manufacturers, both as a marketing strategy and as an additional revenue source. This is the best choice if these technologies are the main measure being considered.
- *Fee-based service companies*. EPC is the only or main service offered by these companies, which grew out of energy management and other contractors. They are the best choice if a wider range of measures is being planned or if the contract is to cover building renovation and long-term facilities management.
- *Utility-based ESCO*. Some electric utilities have set up their own ESCOs to deliver DSM programmes and to provide an additional source of revenue. These are a good choice if the project is focused on electricity or gas technologies.
- *International energy companies*. Some larger power utilities, independent power companies and consulting firms have established subsidiaries in several countries (often through joint ventures with local companies) to offer EPC services. They are the best choice if international connection and overseas technology transfer are critical.

For large organisations, it is also possible to establish an in-house ESCO but the overheads and performance risk must be evaluated carefully.

5.2 Project financing

In principle, the ESCO can arrange financing of the project in many different ways. The measures installed under performance contracts may be financed by the ESCO itself, as a loan from a financial institution or special fund, or by working together with the client. If the ESCO provides the financing, it is termed 'off balance sheet' or 'non-recourse' financing. The ESCO can use its own funds, borrow money, or sign a leasing arrangement. The client has no debt, and its only obligation is to pay the ESCO all or a share of the savings during the contract period. Figure 3 shows a typical financial structure used by ESCO in guaranteed savings contracts. This approach uses the credit strength of the customer directly.

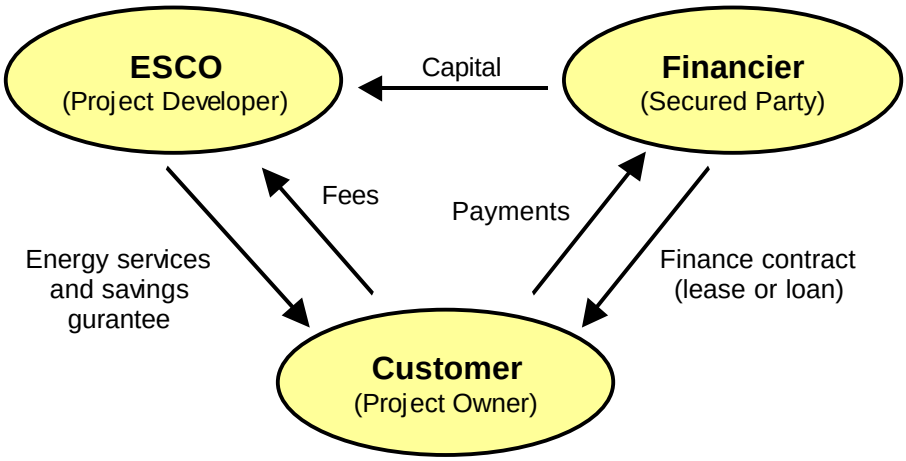

Figure 3. Financial structure used by ESCO

Currently, the investments in energy efficiency are affected by adverse economic conditions. Many small and medium enterprises (SME) do not have the capital to implement energy conservation measures, even with short payback periods. To develop the EPC market for SME, it is necessary for the ESCO to negotiate with the financiers or bankers and use creative financial tools that take advantage of different project characteristics.

5.3 Methods of savings verification

Verifying that savings actually occur is an important part of any performance contract [2]. Three methods are normally used: (a) deemed or stipulated savings; (b) savings based on utility bills; or (c) measured savings. In the case of deemed or stipulated savings, annual payments are made based on savings estimates made before contract signing. A concept study is used to provide these estimates, using measurements or other audit information taken before the project starts, and the performance characteristics of the equipment to be installed. Savings based on utility bills provide the most common method used for savings verification. Here, energy and water savings provide the basis for repayments. Baseline consumption is determined using past energy bills. Savings are calculated using the actual energy bills received throughout the contract period. The third method, measured savings, involves 'before' and 'after' measurement of utility use by the technologies installed in the project. This is the most exact method of determining savings, but also the most costly. Adjustments

have to be made for weather and facility use changes, and because equipment loads can vary from day to day, elaborate protocols need to be established.

The field of measurement and verification (M&V) of energy savings has matured in the last decade [17]. There is a big difference between measuring the flow of energy and predicting the reduction in energy savings based on metered data. For this reason, any discussion of monitoring energy savings must address both objective and subjective issues raised in the evaluation of an energy conservation measure. The recently revised and updated International Performance Measurement and Verification Protocol (IPMVP) (www.ipmvp.org) provides good information and a method for verifying energy savings [18, 19]. Table 1 summarises the IPMVP's M&V options and analysis techniques. A proposed ASHRAE 14-P Guidelines on Measurement of Energy and Demand Savings also aims at filling the information gap. The IPMVP, in conjunction with the Association of Energy Engineers, has recently created a new certification program for those involved in M&V too [17].

Table 1.M&V options and analysis techniques

M&V option	Analysis techniques
Partially measured retrofit isolation	Engineering calculations using short term or continuous measurements
Retrofit isolation	Engineering calculations using short term or continuous measurements
Whole facility	Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.
Calibrated simulation	Energy use simulation, calibrated with hourly or monthly utility billing data and/or endues metering.

The trend in the world shows that building energy simulation techniques are becoming more and more important for the M&V. In Hong Kong, the recent development of performance-based building energy codes will provide a useful basis for carrying out building energy simulation to evaluate and compare building energy performance [20]. This will help to resolve some of the difficulties of setting commonly agreed M&V methods in EPC.

6. CONCLUSIONS

Energy performance contracting is a useful tool for promoting and delivering cost-effective energy efficiency outcomes in the built environment. It is particularly useful for situations where capital investment budgets for energy efficiency retrofits is difficult to obtain by the building owners or developers. With the growing concern of sustainable building performance and the development of government policies on energy efficiency issues, it is believed that the demand for this technique will increase in Hong Kong.

In order to apply the technique effectively to improve the performance of existing buildings, it is necessary to remove the existing barriers to the development of the EPC market and create a performance culture in the building industry. To ensure successful implementation of the technique, suitable skills on technical, business, financial and management issues need to be developed locally among the building professionals. It is hoped that the outcomes will create a comfortable, cost-effective environment in our building stock.

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