Exploring the Feasibility of ESCO Business in Japan: Demonstration by Experimental Study

Chiharu Murakoshi, Jyukankyo Research Institute
Hidetoshi Nakagami, Jyukankyo Research Institute
Tsuyoshi Sumizawa, Shin Nippon Air Technologies Co., Ltd.

ABSTRACT

Since 1996, the prospect for a successful and sustainable ESCO (Energy Service Company) industry in Japan has been investigated and its benefits have been promoted. Consequently thirteen companies, including some large ones, have begun ESCO businesses at present and several more have started to find their ways into ESCO business. In October 1999, the Japan Association of Energy Service Companies (JAESCO) was established, with ESCO organizations and utilities as leaders. Meanwhile, the government formulated the Law concerning the Promotion of the Measures to Cope with Global Warming in October 1998, to promote the Energy Efficient Management Program at national and local administrative levels. This program is expected to be the largest market for the ESCO industry.

Preceeding the above, as an auxiliary project of Ministry of International Trade and Industry (MITI), verification of the feasibility and effectiveness of ESCO business has been implemented using 16 walk-through audits and energy savings retrofits of four commercial buildings. Using the MITI project as a demonstration, this paper discusses ESCO business, particularly energy saving technologies, effectiveness, methods for measurement and verification, financing, and model calculations based on contract period and operating performance after retrofit. In conclusion, we discuss the characteristics and feasibility of ESCO business in Japan. ESCO business has just started in Japan, but the possibility of widening the market is significant. This paper confirms the feasibility of ESCO business in Japan.

History of Creating ESCO Business

ESCO business in Japan has been investigated since 1996, and JAESCO was formed in 1999. Still, ESCO business in Japan has only just begun. Here we explain the intricacies involved in creating the ESCO industry and major changes in policies that have occurred since 1996. The following is a time-line of the major events influencing the development of the ESCO industry in Japan:

1996	MITI set up the Advisory Committee on ESCO Investigation
1997	Kyoto Protocol from COP3
1997	ECCJ formed the Association for ESCO Business Introduction in Japan
1998	ECCJ formed the Committee on ESCO Business Demonstration and the Committee to Investigate Measurement and Verification Methods
1998	MITI set up a system of subsidies for energy efficiency retrofits
1998	Model energy efficiency retrofit demonstration project carried out by the Committee on ESCO Business Demonstration
May 1998	Law Concerning the Rational Use of Energy revised
October 1998	Law Concerning the Promotion of Measures to Cope with Global Warming enacted

June 1999	New Japanese Appliance Energy Efficiency Standards enacted
July 1999	Law for Private Finance Initiative (LPFI) enacted
October 1999	JAESCO formed.

MITI Actions

In 1996 the Ministry of International Trade and Industry (MITI) set up the Advisory Committee on ESCO Investigation. The Committee was charged with investigating the possibilities for diffusion of ESCO business in Japan. In order to implement the Kyoto Protocol from COP3 of December 1997, the government of Japan set forth various energy efficiency policies. For example, the Law Concerning the Rational Use of Energy, commonly know as the Energy Conservation Law, was revised in May, 1998. The Japanese Appliance Energy Efficiency Standards, commonly know as A Top-Runner Approach, were revised in June 1999. The Law Concerning the Promotion of the Measures to Cope with Global Warming was formulated in October 1998. The main interests of the government in introducing ESCO business to Japan are promoting energy efficiency and encouraging economic effectiveness through new business development.

Association for ESCO Business Introduction (1997)

In 1997 the Energy Conservation Center Japan (ECCJ) formed the Association for ESCO Business Introduction in Japan. This committee, consisting of 233 specialists, studied domestic institutional aspects, the content of performance contracts, and Measurement and Verification Protocols (M&VP), and also performed case studies of buildings and factories.

Institutional aspects. Institutional aspects included introduction of project financing, application of flexible rules governing leasing, impediments accompanying the introduction of performance contracting at the national government and local administrative levels, the need for government incentives such as broader subsidies and low-interest loans, the need to implement demonstration projects, and the need for an association of ESCOs. Even now financial institutions do not understand the need to introduce project financing, so this is a continuing issue. Application of leasing is important when project financing cannot be used, but in Japan leasing of supplementary equipment such as heating and cooling equipment is not recognized.

Performance contracting. Regarding the introduction of performance contracting at the government and local administrative levels, the following issues have been identified. (A) Long term contracts are not possible because the budget system is for a single fiscal year. (B) During bidding it is customary to order the planning and implementation of a project from separate vendors. (C) Even with proposal-type bidding, the local authority (local governmental agencies that own and operate facilities, such as schools, administrative offices, hospitals, etc.) estimates a standard bid price and uses this criterion to decide on the successful bidder. Such a method cannot apply to projects like ESCO business where the project content varies with each vendor's proposal.

M&VP. The applicability to Japan of performance contracting and M&VP used in the USA and Europe were studied. As a result, the preparation of a standard contract and research into M&V methods are continuing subjects of study.

Case studies. The 1997 ECCJ study included case studies of industrial and commercial building energy efficiency retrofits. For the industrial case studies factories were surveyed for examples of energy efficiency retrofits. The average investment of the 108 cases was 1.36 million dollars (at 110 yen/$) with a simple payback period of 4.4 years. For the commercial buildings case studies there were walk-through audits of 16 buildings. The average annual energy use was 1,200 to 2,000 mega-joules per square meter (MJ/m^2) and annual outlays for lighting and fuel were $32 to $36/$m^2$. Energy savings were confirmed in 10 of the 16 cases and were nearly all less than ten percent of the base total energy load annually with a simple payback period of about 6 years.

Pursuant to the investigations above, in 1998 ECCJ set up the Committee on ESCO Business Demonstration and carried out model energy efficiency retrofits. They retrofitted four commercial buildings that were different from those in the 1997 case studies. The contents of the model retrofits are discussed in this paper. ECCJ has also formed the Committee to Investigate Measurement and Verification (M&V) Methods, which is currently studying M&V methods and producing a guidebook aimed at ESCO customers. By the way, the authors have been in charge of producing all reports to MITI about investigations of the nascent ESCO industry of Japan.

Law Concerning the Promotion of the Measures to Cope with Global Warming (October 1998)

The Environment Agency set forth the Law concerning the Promotion of the Measures to Cope with Global Warming in October 1998. The objective of this law is, in order to implement the Kyoto Protocol on decreasing CO_2 emissions, to have the government and local governmental or governing authorities take the initiative in carrying out climate change countermeasures. The government and all local authorities must propose, implement, and report on such countermeasures for all buildings that they manage themselves. Japan has 47 prefectural and city governments and 3232 cities, towns, or villages (local authorities). There are various other climate change countermeasures besides energy efficiency, but energy efficiency retrofits are expected to be the central activity. Meanwhile, because local authorities in Japan are in financial distress the likelihood of them accepting performance contracting is high. By 2010, when all local authorities will have implemented their climate change countermeasures, it is possible that such programs will grow to be the largest ESCO market.

Law Regarding to Promote Provision of Public Facilities and Other Related Services by Use of Private Capital and Other Resources (July 1999)

The Economic Planning Agency (EPA) set forth the Law regarding to Promote Provision of Public Facilities and other related Services by use of Private Capital and other Resources, commonly known as the Law for Private Finance Initiative (LPFI) into effect in July, 1999. The EPA prepared the LPFI with reference to the Private Finance Initiative (PFI) of England. The PFI is categorized as third party finance, and there are many points in common with ESCO business. Promoting energy efficiency retrofits is not a goal of the LPFI of Japan, but the law provides policies for the government and local authorities to apply private sector funding when managing public facilities. Until now, when the government and local authorities used private financing they had to do so by bond flotation. The Ministry of Home Affairs set an upper limit on the bond flotation of each local authority, which often served to prevent local authorities from setting independent policies. The goals of the LPFI are to rectify this problem, obtain cost savings and provide efficient services to residents while alleviating financial difficulties of local authorities. Many of the problems that are expected to arise when local authorities try to carry out ESCO business also apply to introducing the PFI. We hope that by implementing the LPFI methods to resolve these problems will become evident.

Private Sector Actions

Private sector actions with respect to ESCO business in Japan have just begun. As of March 2000 there are eight ESCOs in JAESCO. There is one independent ESCO known as First ESCO, and the rest are operating divisions of large corporations. The business status of the thirteen companies is shown below:

Independent ESCO: The First Energy Service Company, Ltd.
Utility ESCO: Gas and Power, Inc. (affiliate of Osaka Gas Co., Ltd.)
Vendor ESCO: Mitsubishi Electric Corporation, Hitachi, Ltd., Sumitomo Metal Industries. Ltd., Omron Creative Facility Co., Ltd., Yamatake Building Systems Co., Ltd., Toshiba Corporation and Matsushita Electric Works Ltd.
Construction ESCO: Chiyoda Corporation.
Engineering ESCO: Nisinippon Environmental Energy Co., Inc., Kinden Corporation and Sankosha Corporation

In Japan, project financing cannot be used for the kind of small-scale projects undertaken by ESCOs. Therefore ESCO business has not been based on performance contracting. Business has been developed contractually based on a work flow beginning with a walk-through audit. Each ESCO company recognizes the need for guaranteeing energy savings to customers because that is a basic premise of ESCO business. In addition, some ESCOs are carrying out cooperative projects with ESCOs in the US to work toward full commercialization of performance contracting in Japan while gaining know-how.

As for utility companies, nine are JAESCO members (Tokyo Electric Power Company, Kansai Electric Power Co., Inc., Chugoku Electric Power Co., Inc., Tohoku Electric Power Company, Hokkaido Electric Power Co., Inc., Chubu Electric Power Co., Inc., Kyusyu Electric Power Co., Inc., Shikoku Electric Power Co., Inc., and Tokyo Gas Co., Ltd.,) but except for Osaka Gas Co., Ltd., utilities have not started ESCO businesses. We think utility company interest in ESCO business will increase, and after they ascertain the current restructuring trends they will decide whether they should commercialize or not. Now, Hokkaido Electric Power Co., Inc. is planning to start ESCO business.

Establishment of JAESCO

The ESCO industry in Japan has developed while receiving support from MITI. However, general knowledge of ESCO business is low, and the barriers for such business are many. In this kind of environment it is not efficient for various businesses to carry out market development separately, so the need for an association of ESCOs was discussed. Meanwhile, it is possible that the market for energy efficiency could grow very quickly.

The main organizations supporting the MITI investigations joined together in 1999. In October they formed JAESCO. The 40 current members are: Jyukankyo Research Institute, ECCJ, Nippon Steel Corporation, Nippon Steel Engineering Osaka Co., Ltd.., Mitsubishi Corporation, and others. The aims of JAESCO are (a) diffusion of and education about the ESCO industry, (b) provision of information related to domestic and overseas ESCOs and information exchange between institutions related to ESCOs, (c) support for research and development of energy efficient technologies related to ESCO business, (d) recommendation of superior ESCOs, and (e) implementation of mediation and amicable settlement of disputes related to ESCO business.

Results of ESCO Demonstration Projects

In 1998 MITI began a demonstration program in which the Ministry subsidized one-third of the cost of a building energy efficiency retrofit. From the buildings receiving the subsidy, four were chosen by the Committee on ESCO Business Demonstration and model retrofits were done using ESCO methods. The goal of the program was to demonstrate to MITI and the public the effectiveness of ESCO business for promotion of energy conservation.

Overview of Demonstration Project Buildings

The four buildings in the study were three office buildings, one of which included a research laboratory, and a research and training facility. Among the targeted buildings there were also some that included factories, but the subject of the evaluation was the office portion. Building A was the largest, with floor area of 33118 m^2, and Buildings B, C, and D were all around 10,000 m^2. Building D was over 30, A over 20, B over 10, and C was less than 10 years old. Energy efficiency measures (EEMs) used for lighting included high-efficiency fluorescent lighting, compact fluorescent lighting, and occupancy sensors for lighting controls. EEMs for electrical equipment included retrofit and control of the number of distribution transformers, and installation of demand controllers. EEMs related to space conditioning included variable speed pumps and fans, insulating films, cold water radiant cooling, reconstruction of hot and cold water supply system, and reduction of power used to supply water. EEMs for equipment to control space conditioning included optimal control of heat source equipment, direct digital control (DDC) of heating and cooling equipment, optimal control of temperature set levels, control of outside air quantity based on CO_2 level, and installation of an energy management system (EMS). Installing cogeneration was also an EEM. The expected rate of annual energy savings from these measures was largest in Building C, at 23% (estimated with electricity as primary energy, at 10.26 MJ/kWh) and lowest in Building A, at 14%. The expected annual energy savings were higher than those in the 1997 case studies.

Baseline Unit Energy Consumption

To determine the baseline annual unit energy consumption (UEC, in MJ/m2-year), utility bill data for energy use for the three years prior to retrofit were used. Because baseline UEC is a critical part of the energy savings retrofit plan it must be determined with sufficient care. Baseline UECs of the demonstration buildings are shown in Figure 1. Utility costs and energy prices are shown in Table 1. UECs ranged from a high of 2,743 MJ/m^2-year (electricity is 10.26 MJ/kWh) in Building B to a low of 1,523 MJ/m^2-

year in Building D. Utility costs ranged from \$51.4/m^2-year in Building B to \$26.4/m^2-year in Building C, generally about \$30/m^2-year. Energy prices over that time were 15.1¢/kWh to 20.5¢/kWh for electricity, about \$1.00/m^3 for natural gas, \$2.00/kg for LPG, and from 27.3¢/l to 36.2¢/l for oil.

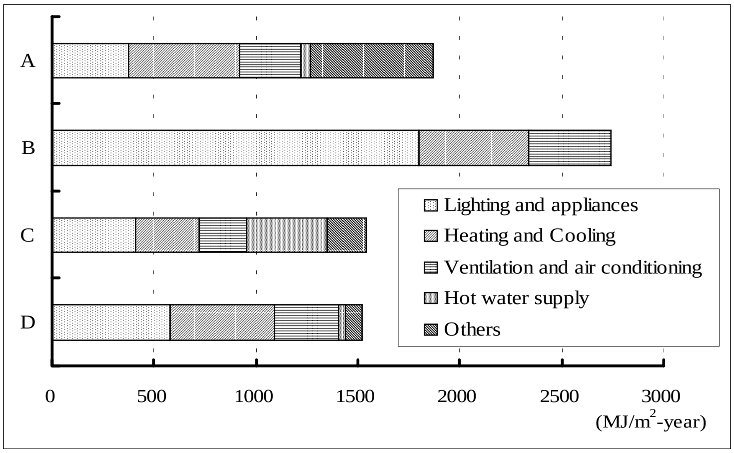

Figure 1. Baseline Unit Energy Consumption

Table 1. Utility Costs and Energy Prices

Building		Unit	A	B	C	D
Total Floor Aria		m^2	33,118	12,750	10,659	9,237
Energy Consumption	Lighting and appliances	MJ/m^2	374.7	1,797.7	411.0	582.9
	Heating and Cooling		543.6	538.9	311.2	511.0
	Ventilation and air conditioning		301.7	406.7	234.9	310.9
	Hot water supply		46.8	0.0	396.3	32.1
	Others		600.8	0.0	189.9	86.2
	Total		1,867.6	2,743.4	1,543.3	1,523.2
Utility Cost		\$/m^2	30.1	51.4	26.4	27.4
Energy Price	Electricity	¢/kWh	14.8	19.1	20.4	20.4
	Average	¢/MJ	30.8	32.7	29.7	31.6

Energy Efficiency Retrofit Specifics and Results of Energy Efficiency Retrofits

In all, 28 energy efficiency measures (EEMs) were installed. About 65% addressed HVAC and 32% addressed electrical equipment. The most frequently used EEMs were variable-speed pumps and fans and retrofit of high efficiency fluorescent lighting. This trend is generally similar for EEMs used in the 1997 case study buildings.

To determine the effectiveness of each EEM, the decrease in the whole building energy use, percentage of decrease attributable, and the payback period were calculated for each EEM. For example, these values for lighting measures are calculated based on catalog values, and those for air conditioning control measures are based on measurements. The decrease in annual whole building energy use ranged from 13.8 to 22.8% and the decrease in annual utility costs ranged from 11.6 to 41.6%. In addition, power reduction was a secondary effect of retrofits, increasing their value.

Cost of Demonstration Retrofits

Costs of the retrofits are shown in Table 2. Construction costs were $683,000 ($21/m^2) for Building A, $932,000 ($73/m^2) for B, $509,000 ($48/m^2) for C, and $1,170,000 ($127/m^2) for D. The simple payback periods (SPPs) (construction cost/annual saved utility cost) are 5.9, 9.0, 4.8, and 13.1 years, respectively.

Table 2. Cost of Demonstration Retrofits

Building	A	B	C	D
Construction Cost($/m^2)	20.63	73.11	47.75	126.66
ESCO Service Charge($/m^2-year)	1.99	3.57	2.05	4.77
M&V Cost($/m^2-year)	0.33	1.28	1.02	1.18
Decrease in Utility Costs($/m^2-year)	3.49	8.08	9.94	9.69
Decrease Cost by EMS($/m^2-year)	0.27	0.71	0.85	-
Simple Pay Back Periods(year)	5.9	9.0	4.8	13.1
Decrease in Whole Building Energy Use(%)	13.8	15.4	22.8	20.8

Percentage of Energy Saved and Simple Payback Period (SPP)

The percentage of energy savings for the whole building and the SPP are shown in Figure 2. Whole building annual energy savings ranged from 22.8% in Building C to 13.8% in Building A. Higher energy savings than those seen in the 1998 case studies (1) have been realized. Buildings A, B, and C had SPPs shorter than 10 years. Building C showed especially good performance with a high percentage of energy saved and a short SPP.

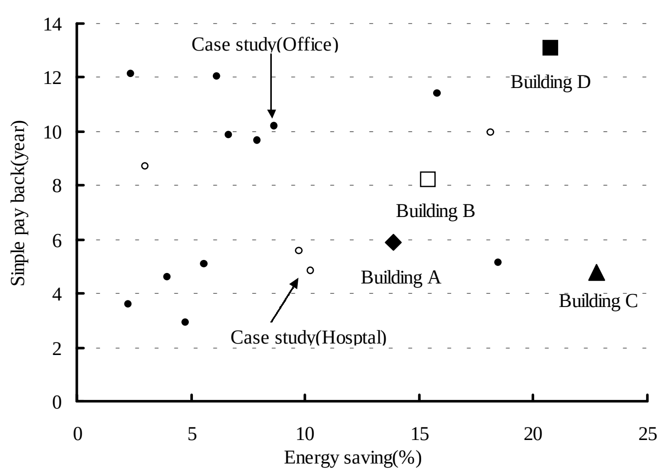

Figure 2. Percentage of Energy Savings for the Whole Building and the SPP

Evaluation by Curves of Conserved Energy

A curve of conserved energy (CCE) is a graph showing the relation between the energy efficient retrofit cost (cents) per unit energy conserved (MJ) and the cumulative amount of energy saved annually (MJ/year) as EEMs are added in order from lowest ¢/MJ to highest. For these calculations we take the useful lifetime of an EEM to be the legally stipulated lifetime of 15 years, which is a reasonable assumption under accounting standards. These curves are shown in Figure 3.

For Building B the overall cost of implementation was 20.2¢/MJ, which does not exceed its 1997 energy price of 32.7¢/MJ, so it is within the range for which recovery of the EEM cost is possible. However, when financing costs and M&V costs are considered, the Building B retrofit can be thought of as at the limit of business an ESCO could conduct. For Building C the overall retrofit cost was 16.0¢/MJ, an efficient investment compared to its 1997 energy price of 29.7¢/MJ. If cogeneration is left out, the overall cost drops to 7.6¢/MJ. We cannot say that cogeneration is definitely a good investment in Building C. If installing cogeneration does not ruin the project economics it can contribute significantly to improving energy efficiency.

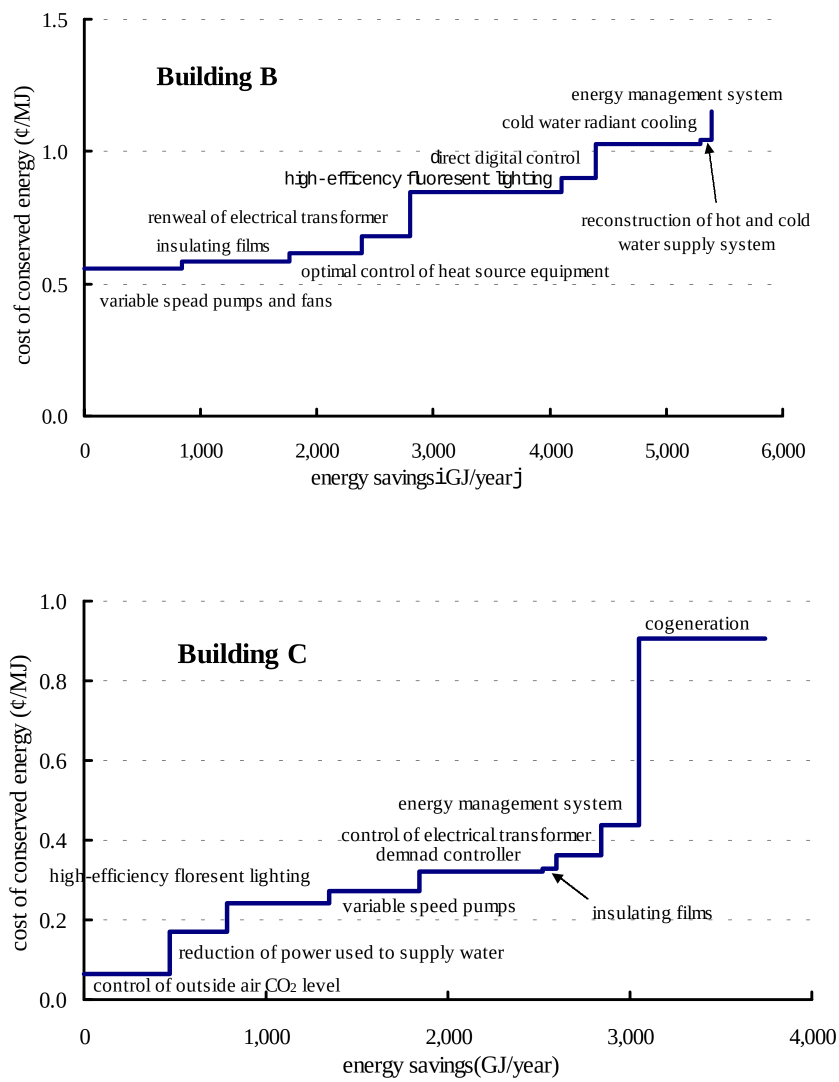

Figure 3. Curves of Conserved Energy for Demonstration Building Retrofits

Simulation of Cost recovery

We estimated the expenses and profit involved in performing ESCO business according to the following assumptions.

Financing: the demonstration building retrofits were all funded by the owners plus the government subsidy, but for estimation we suppose that all financing is borrowed.
Interest rate (r): 3.5%
Repayment: annually, with principle and interest levelized

$$\text{Re payment} = \text{loan}\,\frac{r/100\,(1 + r/100)^n}{(1 + r/100)^n - 1}$$

Fixed Asset Tax: 1.4% of the remaining value of 10%
Contract length (n) in years: no longer than 15 years, the period over which the average annual profit exceeds 10% of the saved utility costs.
Cases: Base Case: all self-funded / Subsidy case: subsidy covers 1/3 of cost

The minimum necessary contract length is shown in Table 3. The shortest possible contract period is until the year when the profit changes from negative to positive. However, in actual ESCO business the client's profit must be guaranteed each year so there must be a somewhat greater margin seen in the contract length. Here we assume that the minimum necessary contract length is that for which the average annual profit during the contract length exceeds 10% of the cost of saved energy. This minimum contract length corresponds to a little less than twice the SPP.

Table 3. Minimum Necessary Contract Length (years)

Building	A	B	C	D
Base Case	10	17	7	>30
Subsidy Case	6	11	5	17
SPP	5.9	9.0	4.8	13.1

Market Barriers

There are financial, institutional, and technological issues that must be overcome in order for the ESCO industry is to spread in Japan. In particular, there is a close connection between performance contracting and project financing, but there is no experience in Japan with using project financing for the kind of small-scale projects handled by ESCOs. Also, in what is probably the biggest market, local authorities, there are various institutional issues to be solved.

Project Financing

Generally, financing in Japan is done by asset coverage and corporate financing. For these, the maximum financing limit is set individually for each corporation, and financing of the core business has priority. Many energy efficiency retrofits have long payback periods, so the corporation has little incentive to obtain financing for investment in energy efficiency. Utilities in Japan have extremely high credibility, and also high credit limits. But when utility ESCOs try to carry out shared savings contracts they do not use credit, even though their credit limit is big enough to do so. They seem to prefer to use their credit for other projects. Through project financing, credit exceeding the limit mentioned above can be obtained, but since this has not been done in Japan, lenders do not approve of this practice. When a large-scale construction project needs project financing, a Special Purpose Company (SPC) is set up to provide a risk hedge for the lender, but for small scale projects such as ESCO business, the costs of establishing an SPC are prohibitive. Instead, performance contracting could become the risk hedge for financiers, but lenders do not understand this point. However, since enactment of the LPFI there is starting to be an inclination inside financial institutions to use project financing. Also, as lenders are interested in ESCO business, provided that the risk hedge function of performance contracting becomes appreciated, it may become possible to apply project financing in Japan.

Issues of Application to Local Authorities

Local authorities are expected to be the largest future market for ESCO business but various institutional issues remain to be solved. Local authority budgets are only for a single fiscal year, so legislative approval is needed for long-term contract obligations such as performance contracting. But there are no precedents of such long-term contracts in Japan, and even if they are possible in theory, they are difficult to realize in practice. When a local authority manages a construction project orders are made via bidding, but it is a well-guarded custom to award the planning and implementation to separate vendors. For performance contracting planning and implementation must be bundled so this custom must be overcome. For general bidding the local authority issues an estimated price that is used as a standard in choosing vendors. The lowest bidder does not necessarily win the contract. But, the criterion for choice of vendors is only price, so this system cannot apply to situations such as ESCO business where the proposal content varies for each bidder. A system for proposal-type bidding has been set up to solve this problem, but even here the vendor is determined based on being within the estimated price range. When raising funds, whether the local authority bears the cost or floats bonds, the single fiscal year budgeting system means that long-term financing cannot be borrowed from the private sector.

As explained above, large barriers to application of ESCO business to local authorities still exist. With respect to the provision of infrastructure, the LPFI was enacted, and ways to solve these issues are being studied. Also, several local authorities are already studying the possibility of performance contracting under the present system. For ESCO business, this may show that remedies can be found.

Conclusions

Energy consumption by office buildings in Japan is 1,500 to 2,000 MJ/m^2-year, costing about $\$30/m^2$-year. Investment in energy efficiency retrofit can be considered profitable at about $\$50/m^2$ with contract lengths of 7 to 10 years. Energy efficiency measures possible within this range are mainly retrofits of lighting and space conditioning equipment, but the possibility of installing cogeneration is also high. The market for ESCO business focuses on hotels, hospitals, and office buildings, but probably the biggest future market will be local authorities. However, there are many institutional issues that must be solved for ESCO business to be carried out, such as the absence of project financing. Government support measures, in particular those of MITI, are in the process of maturing. MITI is expanding its program of subsidies for energy efficiency retrofits, and through the Environment Agency, the Law concerning the Promotion of the Measures to Cope with Global Warming is expected to greatly promote energy efficiency retrofits by local authorities. The industry association, JAESCO, has been set up, and the private sector has taken notice of the future of ESCO business. The role ESCO business will play in global climate change countermeasures is expected to expand.

Acknowledgment

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