How could public sectors facilitate to procure professional energy management service for buildings?

Tomonari Yashiro  
Professor, Institute of Industrial Science, The University of Tokyo, Japan  
E-mail: yashiro@iis.u-tokyo.ac.jp

Abstract. Professional energy management service could be the useful measure to reduce greenhouse gas emission from the operation of residential and commercial buildings because it can provide professional knowledge to set up the optimized solution that is suitable to the specific conditions and contexts of each building. Though technologies relating to energy management service have been progressed intensively due to the fruit of rapidly undergoing digitalization, the service does not establish business eco-system yet. The paper discusses how policy measures could enhance the dissemination of the service. It focuses on the aspect that public sectors could be the largest client to the emerging service. Based on the debate with policymakers in which the author has committed, the paper identifies significant issues to be considered to establish a standardized contractual framework to procure the service by public sectors. Once the framework is formulated, it could be usable as a template for the standardized template for the procurement contract among the service providers and clients including private sectors and individual owners and users of buildings.

1. Introduction – Why professional energy management service?  
Operational energy use in building causes around 30% of CO2 gas emission among the nationally total amount in the developed world (For example, Greenhouse Gas Inventory Office of Japan, 2018; United States Environmental Protection Agency, 2016; Construction Canada, 2013). The investment in the saving of operational energy use in the building is the most cost-effective measure among the investment in the other sectors (IPCC, 2007). Therefore, the saving of operational energy use of buildings is the significant and cost-effective measure for the reduction of greenhouse emission. In order to facilitate to reduce operational energy use in building, governments and public agencies have taken varieties of policy measures that include regulatory control such as the penalty for excessive use of energy. However, the measures have made a limited effect. The statistics do not show the remarkable reduction of greenhouse gas emission in residential sectors and non-industrial (i.e., commercial) sectors. For example, in Japan, the nationally total amount of CO2 gas emission from the residential sector in 2016 is 144.8% of the amount in 1990 and that from the commercial sector in 2016 is 165.8% of the amount in 1990, while that from industrial processes is 70.2% of the amount in 1990 (Greenhouse Gas Inventory Office of Japan, 2018).

There seem to be several reasons why the previous and current set of policy measures has not to generate sufficient effects against the increasing demand for energy use in the building. One of the significant reasons is that owners and users of buildings served for residential and commercial sectors have limited knowledge to reduce the greenhouse gas emission from the operation. It is difficult for them to identify the appropriate way to reduce greenhouse gas emission from their building operated under specific conditions and context.
Even if regulatory policy measures for excessive energy use should be introduced, the effect of the measure is restricted because the most of owners and users are supposed to be not able to specify the wasteful or inefficient energy use behind the operation of their buildings. Besides regulatory measures, information provision can be another measure. It could have considerable effect by providing instructive information to owners and users by assisting to manage the reduction of operational energy use in the buildings. Government and public agencies have already drafted instructive guidelines for the reduction of operational energy and diffused the guideline through publication, website, and so on. However, as the statics shows, it seems that the effect of such provision of information is limited. The readers of instructive guidelines can get generic information, but not able to find how generic information could apply to the specific conditions and contexts for their buildings. Instead of or in addition to the provision of generic information, professional knowledge is required to manage complicated technologies employed in each building that is operated in specific conditions and contexts. Therefore, it is desirable to introduce another way by which the owners and users of the building can take effective actions that are customized and optimized to the specific conditions and context for each building. Professional energy management service could be such a way; it makes the diagnosis to identify specific conditions and context. Then it defines, executes and monitors the appropriate method of reduction for the building. Such professional energy management service has been rapidly developed and deployed thanks to the rapid progress of ICT. The service has generated a considerable effect on the reduction. However, the owners and users are not easily accessible to such professional energy management service. Consequently, a small amount of explicit demand to the service restricts the growth of the professional energy management service. In order to escape from such a “chicken-and-egg” situation above, this paper explores how public sectors could facilitate to disseminate professional energy management service for residential and commercial buildings. It focuses on the potential impact of procurement of professional energy management service by public sectors as a driver to facilitate the dissemination of the emerging service provided by varieties of entrepreneurs.

2. What is professional energy management service?

Figure 1 illustrates the example of a system framework employed by professional energy management service for the case of the zero-emission oriented building in the University of Tokyo (Yashiro, 2011 and 2013). The system has been innovated thanks to the rapidly developing IoT oriented technologies including networking, sensing, machine learning and so on. The system deploys sensors that collect data on energy use and indoor climate of the building. Using a sort of machine learning technology, application of the system analyzes the collected data to identify specific characteristics and conditions of operational energy use of the building. Then it identifies the optimized method to reduce operational energy and plan a set of actions and commands to things that influence on the operational energy use.
Figure 1 The example of system framework for professional energy management service (Case used for zero emission oriented building in Komaba campus of the University of Tokyo)

The plan is executed and continually modified through the feedback and learning from continuous monitoring and assessment of the performance. Professional energy management system embodies such continual improvement processes.

Figure 2 shows the outline process of continual improvement (Yashiro, 2008).

Figure 2 Continual improvement processes in professional energy management system (source Yashiro 2008)
Though the system framework is generic, in order to apply the system shown in Figure 1 and 2 in specific conditions and context of each building, professional knowledge is required in the deployment of sensors, analytics of collected data from sensors, plan of the optimized set of actions and control of equipment, monitoring and performance assessment and continuous revision of the plan.

In the developed world, entrepreneurs have started up professional energy management service providers. Though they have reduced a considerable amount of greenhouse gas emission from the buildings of their client, the service does not establish business eco-system yet due to the restricted dissemination to the market so far.

3. Potential impact by public sectors as the largest clients
Like other starts up businesses, smart energy management service is on the way of dissemination. From the aspect of the need for a holistic approach to reducing operational energy use in buildings, it is expected that policy measures are taken to facilitate the dissemination. The service is provided based on the contract between the service provider and the owner or user of buildings.

Regulatory intervention on the contract could have both positive and negative impact on the dissemination. Rather procurement policy of the government and public agencies could have a significant impact because public sectors themselves own and operates a vast amount of buildings for the provision of public service. In other words, public sectors could be the most significant clients to the energy management service.

If public sectors proactively procure the service, stakeholders and the general public recognize the potential effect of the service. Contractual framework to procure the service procured by public sectors could be a template for the standardized contract among private sectors and individual owners and users of the building.

Based on such expectation, the author has proposed to include the professional energy management service for building to the framework of the national green contract initiative. Then the author has committed in the policy debate on how the service could be included in the initiative.

4. Procurement framework for the professional energy management service
The policy debate in which the author has committed identified the following issues are significant to establish a workable contractual framework of procurement that enables public owners and users of buildings easily accessible to the professional energy management service;

- method of calculation of the fee to the service
- method of appointing the service provider
- contractual incentives for building owners and service providers

4.1. Method of calculation of the fee to the services
For the healthy growth of the energy management service, the basis of the calculation of the fee to the service should be formulated and standardized. From the client’s aspect, the fee should be calculated based on how much the service has generated the benefit for the client (i.e., the reduction of operational energy use, improvement of indoor air quality), while service providers are supposed to wish to include the cost for provision of the service as well for the calculation of the fee.

At any rate, the method of calculation and benchmarking of the reduced operational energy uses by the service is essential for the formulation of the agreement of the fee between the service provider and clients.

ISO 16745 is usable as a reference as a basis of the terms such as delivered energy, energy carrier, energy source and exported energy that are necessary to define the formulation in the contract. ISO 16745 also provides the basis to define the system boundary of the calculation of energy (Figure 3).
The operational energy in the building can be calculated using the terms and the boundary definition included in ISO 16745-1:2017. In principle, the reduction is defined as the difference between the quantity of operational energy before the introduction of service and those after the introduction of the service. However, in reality, there could be a diverse understanding of the difference.

Figure 4 presents the issues to be considered to construct consensus on the method of the calculation of the difference.
Figure 4 illustrates the influence of the deviation and annual variance of climate such as “unusually hot summer.” The figure also illustrates the change in the mode of building operation. For example, the extension of business hours, the increase of users and the installation of mainframe computers after the introduction of service could undermine the effectiveness of the reduction of operational energy use by professional energy management service.

In order to establish the agreeable and fair reference to calculate the actual contribution of the service to the reduction of operational energy use, the standard document or consensus method shall be formulated to establish the agreed method to assess the influence by natural phenomenal variances and by the change in the mode of use of the building.

4.2. Method of appointing the service provider

Public sectors are required to enhance accountability and transparency for the procurement of services. The service provider should be appointed as a competitive basis. Healthy competition in a marketplace is also expected to enhance the growth of professional energy management service industry. Then what type of selection and appointment is healthy and accountable?

The policy debate in which the author has committed has identified the following issues are critical to defining the procedure of appointing the service provider.
- duration of terms of the contract
- method of assessing the capacity and performance

4.2.1. Duration of terms of the contract

The most of services procured by public sectors tend to be a single fiscal year basis. However, operational energy use could be influenced by seasonal factors. In the case of a single year basis, empirical knowledge from the learning of four seasons is not able to feedback to the management in the following year. The debate has suggested at least three years duration of the contract is reasonable from the aspect of enjoying the benefit of feedback from empirical knowledge created through learning by doing process.

4.2.2. Method of assessing the capacity and performance

At the timing of writing of this paper, performance criteria and indicators of professional energy management service are not defined yet due to the beginning stage of the start-up business. However, it should be defined in the procurement of the service by public sectors. The following issues should be considered in assessing the capacity and the expected performance of the service provided by the applicant for the contract;
- Professional Career of the persons who are in charge of the service
- Previous achievement of the service provider
- The proposed set of key performance indicators and their assessment method that are included in the contract
- The proposed method of continual improvement
- List of identified risks and proposal on risk allocation

4.3. Contractual incentives for building owners and service providers

In general, energy management service requires an initial investment to deploy sensors, set up a network system and tune up analytic tools. How to share the initial investment between the service provider and clients could be the contractual incentive. Besides, the bonus for better achievement (e.g., more reduction than the agreed target) could be the incentive for the service provider. Energy management service is not one-shot service. It is a long term basis service provision. Rather than an adversarial relationship, long-term partnership is beneficial for both the providers and clients because it enables us to enjoy the benefit of continual improvement through feedbacks from learning by doing the process. The appropriate incentive should be included in the contract to facilitate long-term partnership.
5. Concluding comment
The paper explores the way how public sectors could facilitate to disseminate professional energy management service to publicly operated buildings. It identifies the method of calculation of the fee to the service, the method of appointing the service provider and the contractual incentives for building owners and service providers are essential issues to establish a contractual framework for the procurement of the services by public sectors. Because public sectors could be the largest client to emerging service, if the procurement contract framework of the service is successfully established, it could be a driver to disseminate the service not only to public sectors but also to private sectors and individual users of residential and commercial buildings.

6. References

[1] Greenhouse Gas Inventory Office of Japan, The GHG Emissions Data of Japan (1990-2016), May 29 2018 (Retrieved from http://www-gio.nies.go.jp/aboutghg/nir/nir-e.html dated on 30 January 2019)

[2] United States Environmental Protection Agency, Greenhouse Gas Emissions by Electricity End-Use(Retributed from https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions dated on 30 January 2019)

[3] Construction Canada, Transparency in the Built Environment: Calculating and assessing embodied energy of construction materials, October 27, 2013 (retrieved from https://www.constructioncanada.net/transparency-in-the-built-environment-calculating-and-assessing-embodied-energy-of-construction-materials/ dated on 30 January 2019)

[4] IPCC, the Fourth Assessment Report (AR4); {WGIII Figure SPM.6}: Estimated economic mitigation potential by sector and region using technologies and practices expected to be available in 2030, 2007

[5] YASHIRO, Tomonari, Information embedded building for sustainable living, Proceedings of the Conference on Sustainable Building SB08 Melbourne, 2008

[6] YASHIRO, Tomonari; OOKA, Ryozo. Zero energy building project in the University of Tokyo. In: 2011 Helsinki World Sustainable Building Conference, Finland. 2011.

[7] YASHIRO, Tomonari; OOkA, Ryozo; MAGORI, Bumpei; SAKO, Hiroshi; SHIDA, Hiroyuki, Smart energy management system for zero energy buildings , Proceedings of the SB13 Singapore - Realising Sustainability in the Tropics, 2013

[8] ISO 16745-1:2017 Sustainability in buildings and civil engineering works -- Carbon metric of an existing building during use stage -- Part 1: Calculation, reporting and communication