PEER-REVIEWED PAPER

Does regulation of energy management systems work? A case study of the Energy Conservation Law in Japan

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Keywords

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Abstract

This paper examines the Japanese experience of regulating energy management in industrial and commercial facilities with the aim to provide insights for current debates concerning energy management systems (EnMSs). The Energy Conservation Law (ECL) in Japan is a mandatory regulation concerning energy management that applies to the approximately 12,000 companies that consume more than 1,500 kL of crude oil equivalent per year. Requirements of the regulation include annual reporting of energy use, the use of qualified energy managers, the development of long-term energy efficiency investment plans, and the establishment of energy management manuals for major energy-consuming equipment. Compared with ISO 50001, an international EnMS standard, the ECL is unique in several ways, such as the inclusion of performance standards i.e. a 1 % improvement in energy intensity per year. Based on literature review and interview surveys of regulated firms in Japan, the paper argues that, while the regulation has played an important role in establishing basic EnMSs, in many cases it has not been effective in promoting tangible energy efficiency activities beyond mere compliance with the regulation. The paper concludes that programs aiming to enhance EnMSs need to be supplemented with a more informational approach, such as energy audits and customized advice, that supports firms that lack the ability to make use of their EnMSs.

Introduction

Industrial and commercial energy use account for a substantial portion of total energy use in many countries. Improving energy efficiency in such sectors plays a vital role not only in reducing environmental impact but also in increasing productivity and competitiveness of companies. Energy management is considered to be an effective approach to increase energy efficiency in facilities. Energy management systems (EnMSs) are a collection of procedures and practices for the systematic management of energy use to minimize environmental impact (Reinaud et al., 2012). Policies and programmes to encourage firms to adopt EnMSs are gaining interests in many countries. In recent years, countries such as Denmark, Sweden, and Ireland have developed national standards for EnMSs (Pierre, 2009; Gudbjerg, 2011). A European standard on EnMSs, EN 16001, was established in 2009, followed by an international standard, ISO 50001, in 2011. While these standards provide an important basis for developing proper EnMSs, public policy and programs are also required to stimulate and support companies in adopting EnMS standards and pursuing effective energy management (Goldberg et al., 2011; Reinaud et al., 2012). Evaluating and comparing the experiences of existing programmes should be of great use in designing better programs.

The purpose of this paper is to provide insights for the current debates on EnMSs by examining Japan's experience with energy management regulation under the Energy Conservation Law (ECL). The ECL in Japan is a mandatory energy management regulation that applies to the approximately 12,000 companies that consume more than 1,500 kL of crude oil equivalent per year. Requirements of the regulation include annual reporting of energy use, the appointment of qualified energy managers, the involvement of top management, the development of long-term

energy efficiency investment plans, and the establishment of energy management manuals for major energy-consuming equipment. In sum, the law requires firms to have a complete EnMS. As is shown in this paper, the requirements and standards of the ECL have many similarities with, as well as some important differences from, those of ISO 50001. The law is also unique in that it seeks to promote the adoption of EnMSs through a regulatory approach that includes punitive measures for noncompliance. Energy management regulation under the ECL in Japan provides an interesting case for examining EnMS policies.

The paper is structured as follows. First is an overview of the energy management regulation under the ECL and provides a comparison with ISO 50001. The next section evaluates the effectiveness of the regulation through literature review, interview surveys, and a company case study. The section after that discusses insights from our analysis and makes recommendations for EnMS programmes.

Energy management regulation under the Energy Conservation Law (ECL) in Japan

The ECL has been the central pillar of energy efficiency policy in Japan. It encompasses almost all policy approaches to energy conservation, including regulatory, economic, and informational ones, and covers energy use in all sectors, from industrial to residential use. This paper focuses on provisions of the ECL concerning industrial and commercial facilities. In this section, we first provide an overview of the energy management regulation for firms as of 2014. Then, we compare it with ISO 50001 to better understand the characteristics of EnMS regulation in Japan.

OVERVIEW

Scope of regulation

The ECL designates companies that consume more than 1,500 kL of crude oil equivalent per year[1] as "Specified Business Operators" (SBOs). A franchisee consuming above this amount of energy is also designated as a "Specified Chain Business Operator" (SCBO) (ECL Articles 7 and 19). The energy use of an SBO or SCBO (hereafter referred to as a specified company) is the sum of energy used at all sites operated by the SBO or franchised by the SBCO. This means that not only large industrial factories but also commercial buildings can be subject to the regulation if they are franchised or owned by a company with several locations. The current specifications for SBOs and SCBOs were introduced in the 2008 amendment to the ECL. Before the amendment, only an individual location that consumed more than 1,500 or 3,000 kL of crude oil equivalent per year was designated as a Type-1 or Type-2 "Designated Factory," respectively (hereafter, a DF). Although the unit of regulation was expanded to a company or a franchise chain from a single location in the 2008 amendment, the DF designation is still active after the amendment, which means that specified companies have both company-level and location-level regulations. In 2010, there were 12,151 SBOs, 104 SCBOs, 6,852 Type-1 DFs, and 7,008 Type-2 DFs (ECCJ, 2012). The energy use of specified companies under the ECL covers a quite high portion of total industrial and commercial energy use, 98 % and 45 % for industrial and commercial energy use in 2010, respectively (ECCJ, 2012). No official statistics are available on the share of small- and medium-sized enterprises (SMEs) among specified companies. A survey by IEEJ (2012) shows that about 30 % of Type-1 DFs were SMEs. This implies that the SME share in specified companies, which includes smaller locations than DFs, is at least equal to that amount or higher.

Major requirements

While the ECL requires all energy consumers to make efforts for energy conservation, only specified companies are subject to several mandatory requirements, which follow.

Appointment of energy managers and establishment of a responsible organization

A specified company must nominate three kinds of energy managers: an "Energy Management Control Officer" (hereafter, a Control Officer), who is from the top management and supervises all aspects of energy management of the company; an "Energy Management Planning Promoter" (hereafter, a Planning Promoter), who supports the Control Officer; and an Energy Manager, who conducts energy management in day-to-day operations (ECL Articles 7-2, 7-3, 13). Nominated Planning Promoters and Energy Managers are required to complete a one-day official training course on energy management provided by the government (ECL Article 13). In addition, Type-1 DFs in energy and manufacturing industries must appoint "Qualified Energy Managers" who have a national license for energy management (ECL Articles 7-4, 8, 9, 17). Energy Managers are often non-engineers nominated from a general affairs division, whereas Qualified Energy Managers are usually engineers from a facility management or production divisions. Control Officers must take the opinions of Energy Managers and Qualified Energy Managers into consideration, and workers in specified companies must follow their instructions when necessary (ECL Article 19-3).

Compliance with the EnMS standard

The ECL establishes the "Standard of Judgement for Rational Use of Energy in Factories" (ECL Article 5). Since the standard specifies the energy management practices and processes that firms are required to adopt, the standard is hereafter referred to as the EnMS standard of the ECL. The EnMS standard has both qualitative specifications and quantitative standards, and firms must comply with both. In addition, the standard also includes medium- and long-term targets that firms should achieve. One such target is energy intensity improvement by an average annual rate of 1 %. The EnMS standard constitutes the core element of the energy management regulation under the ECL, so it is discussed in greater detail later in this subsection.

Annual reporting

A specified company must submit two kinds of annual reports: a "Periodical Report" (ECL Article 15) and a "Medium- and Long-Term Plan Report" (ECL Article 14). The periodical

1. 1,500 kL of crude oil equivalent per year is approximately equivalent to 3,000 t-CO_2 per year. This is a much smaller threshold than that of EU-ETS, 20 MW thermal input. The share of factories with less than 10,000 t-CO_2 emission is only 31 % of those covered by EU-ETS in terms of number of factories (Graus & Voogt, 2007), whereas the share is approximately 70 % in the case of the ECL in Japan.

report includes the company's annual energy consumption, energy intensity (defined as energy consumption divided by a production index) and its five-year trend, and the result of self-compliance check for the EnMS standard. If a company fails to achieve an 1 % improvement in its energy intensity index, the reason for the failure must be explained in the report. The periodical report mainly concerns daily and annual management of energy use, and the medium- and long-term plan report is meant to promote investment measures that often require several years of consideration for financing. In the medium- and long-term plan report, firms must list their planned investment measures with a schedule of implementation and expected reductions. If any planned measures are removed or added from the plan, this must be noted and a reason for the removal or addition must be given.

EnMS standard and targets

The EnMS standard of the ECL consists of two parts: the standards section, which deals with compliance with specified standards, and the targets section, which addresses achievement of quantitative targets in the mid- to long-term as well as measures necessary to achieve those targets. The structure of the standard is presented in Table 1.

Standards section

The preamble of the standards section outlines six standards for the entire EnMS of a company or franchisee chain. The main part lists standards for major energy-consuming equipment and processes. The standards are detailed for commercial facilities (I-1) and for industrial factories (I-2). For each type of equipment and process, standards are structured from four perspectives: (i) operations, (ii) measurement and recording, (iii) maintenance and inspection, and (iv) installation of new equipment. Because equipment and processes vary to a great extent from firm to firm, most of the standards are qualitative and must be specified in each firm's management manuals. For example, a standard for the operation for air-conditioning and ventilation equipment in commercial facilities (Section I-1-(1)-(i)) is prescribed as follows:

> Air-conditioning shall be managed by limiting the zone of air-conditioning, and by setting management manuals on the use of window shade, operating hours, indoor temperature, frequency of ventilation, moisture, and introduction of outside air, etc.

Thus, the EnMS requires firms to determine the conditions at which equipment and processes achieve their highest efficiency on the basis of measured data, standardize them in management manuals, manage the equipment and processes according to the manual, and maintain them. The standards section also has a set of quantitative standards for a limited number of common items, such as the air ratio and temperature of exhaust gas from boilers and furnaces, the heat recovery rate of furnaces, the temperature of the outside wall of furnaces, and the power factor at the power receiving end.

Targets section

The targets section sets a target for companies to improve their energy intensity by an average of 1 % or more annually in the mid- to long-term. To achieve the target, the targets section also specifies measures and technologies that are recommended for adoption. In addition, four industries are identified that should seek to achieve an industry "benchmark target". The four industries, all energy intensive industries, are pulp and paper manufacturing, petrochemical basic products manufacturing, cement manufacturing, and iron and steel manufacturing. For example, iron manufacturing factories with blast furnaces should, in the medium- and long-term, achieve the target level of 0.531 kL or less of crude oil equivalent per ton produced, calculated by dividing the energy use in its blast furnaces by the amount of raw steel produced.

Verification of compliance and penalties

Verification of compliance with the EnMS standard is done through a review of annual reports and the use of an "on-site survey." The on-site survey consists of a document review and a one-day on-site survey by expert auditors who are sent from the Energy Conservation Centre Japan (ECCJ). On-site surveys have been conducted since 2001. In the beginning, the surveys targeted all Type-1 DFs, which amount to more than 11,000 factories. The survey's scope was later expanded to Type-2 DFs, as well as to SBOs and SCBOs, which are randomly selected for review. Because the number of DFs and specified companies is quite large, about 400 to 800 facilities and companies are surveyed annually on a rotating basis. While the on-site survey is just a "survey" by the government and has no legal status, in practice it has been playing an important role in the verification of compliance with the law. [2]

The ECL allows the government to give "guidance and advice" on energy conservation to any companies (ECL Article 6). Furthermore, for specified companies, the government may conduct inspections (ECL Article 87) and order that an "improvement plan" be made and implemented in the event of serious noncompliance (ECL Article 16). The government can publicise when the company fails to follow an order,[3] and in the worst cases, companies may be fined up to 1 million JPY (approximately 7,700 EUR)[4] (ECL Articles 16, 95). Typically, about 30 to 100 companies are given guidance and advice and 10 to 20 companies are inspected annually, both on the basis of results of the on-site survey. No companies have yet been ordered to create an improvement plan (METI, 2005a, b; Kimura & Noda, 2010).

COMPARISON OF THE ECL WITH ISO 50001

Comparison of the EnMS with ISO 50001 will give us a better understanding of the characteristics of the energy management regulation under the ECL. A comparison of the two standards on each element in the Plan-Do-Check-Action (PDCA) process is presented in Table 2.

2. Alternatively, the ECL has procedures for "registered investigation bodies," which conduct verification surveys, similar to on-site surveys. As of 2013, seven consultancy companies were registered as such bodies (METI, 2013). While specified companies that are certified as compliant with the EnMS standard by a registered investigation bodies are exempted from annual reporting to the government and on-site surveys, there seems to be only a limited number of investigations by such bodies in practice, mainly because there is no incentive to pay for such investigations.

3. In Japan a "name and shame" approach is considered to be effective and is commonly used in environmental policy (Kimura, 2012).

4. The currency conversion assumes an exchange rate of 130 JPY/EUR.

Table 1. Structure of the EnMS standard of the ECL (source: METI & ECCJ, 2010).

I. Standards section			
	Preamble: General standards on energy management systems		
		A. Establishment of energy management systems B. Appointment of responsible managers C. Establishment of energy conservation policies	D. Check and review of compliance with policies E. Periodic review of the check-and-review methods F. Documentation of energy profile
	1. Standards for major energy consuming equipment in offices and other commercial facilities		
		(1) Air conditioning and ventilation equipment (2) Boilers and hot water supply (3) Lighting, elevators, and other motor systems (4) Electrical equipment and BEMS	(5) Generators and cogenerators (6) Office automation equipment and appliances (7) Commercial equipment (e.g., refrigerators) (8) Other equipment
	2. Standards for major energy conversion processes in industrial factories		
		(1) Efficient fuel combustion (2) Efficient heating, cooling and heat transfer (3) Heat recovery	(4) Efficient conversion of heat into other form of energy (5) Reduction of energy loss by eradiation etc. (6) Efficient conversion of electricity into heat, etc.
II. Targets section			
	Preamble: General targets A. Improvement of energy intensity by one percent per year on annual average B. Achievement of industry benchmark index (specified for four energy intensive industries)		
	1. Target measures for major equipment in commercial facilities (the same structure as the Standard section)		
	2. Target measures for major energy conversion processes in industrial factories (the same structure as the Standard section)		

Note. For each equipment and process in the Standards section (I-1 and I-2), standards are detailed from four perspectives: (i) operations, (ii) measurement and recording, (iii) maintenance and inspection, and (iv) installation of new equipment.

As shown by Table 2, the current EnMS standard in the ECL requires continuous improvement of energy performance and EnMSs, and has many similarities with ISO 50001. In fact, several companies claim that they were certified to ISO 50001 with little additional action compared to their energy management practices under the energy management regulation by ECL (METI, 2013). However, there are also some notable differences. Five important points that differentiate the EnMS standard of the ECL are explained.

First, the EnMS standard of the ECL has specified energy baselines, performance indicators, and quantified targets, such as the 1 % annual improvement discussed earlier. These specification is a substantial difference compared with ISO 50001, which requires companies to set their own energy baselines, performance indicators, and targets. A common target of a 1 % improvement in energy intensity for all companies was introduced to the EnMS standard in the 1997 amendment to the ECL. While the common target of improvement can be a strong incentive to enhance energy conservation efforts, it is often criticised as being unfair because potentials of improvement depend on various factors other than conservation efforts. To address this problem, the government is trying to introduce benchmark indexes and targets into the ECL as better quantitative targets. As of 2013, four energy intensive industries have specified benchmark indexes and targets.

Second, the EnMS standard specifies energy conservation measures that should be implemented by all companies, as well as management manuals that should be created by companies themselves. This also differs from ISO 50001, which does not specify any conservation measures. This difference reflects the history of the EnMS, which was originally developed as guidance on energy conservation measures for all energy-consuming companies, rather than standards with which companies must comply (Okamoto, 1980). The provision requiring companies to implement facility-by-facility and equipment-by-equipment energy management by considering and adopting measures detailed in the EnMS standard has been a core element of the ECL (ECCJ, 2008a).

The third main point of the EnMS standard is the high importance of management manuals. Since the majority of the clauses in the EnMS standard require companies to develop their own management manuals, it can be said that the ECL places a strong emphasis on developing and making use of the manuals in operations, measurement and recording, maintenance and inspection, and the installation of new equipment.

The fourth point to note is the weak provisions on the planning process in the ECL. This is partly related to the first and the second points we made above because the EnMS standard provides quantitative targets and a list of measures to be adopted as a reference. Thus, companies do not need to make decisions on targets and measures. Specified companies must develop a medium- and long-term plan, but it does not necessarily relate to the energy intensity improvement target. Furthermore, the report is meant for investment measures, and there is no requirement to establish an action plan on operational measures, since such measures are expected to be implemented if the company has proper management manuals for major equipment and processes.

The fifth point is that the ECL has weak provisions concerning the check and review process. Explicit provisions on the PDCA process for energy management were not introduced into the EnMS standard until the 2008 amendment. Before the amendment, it was implicitly assumed that companies with responsible organizations for energy conserva-

Table 2. Key components of EnMS in ISO 50001 and the EnMS standard of the ECL.

PDCA	ISO 50001	Energy Conservation Law and its EnMS standard
Plan	Energy policy (4.3)	– Companies should set policies on energy conservation efforts, including targets on energy conservation and policies on installation and replacement of equipment (EnMS I-Preamble C).
	Energy plan (4.4)	– Specified companies must submit a medium- and long-term plan report annually (ECL Article 14), in which investment measures to achieve its target must be listed.
	– Energy baseline (4.4.3) – Energy performance indicators (4.4.5) – Energy objectives and targets (4.4.6)	– Companies should improve their energy intensity, defined as energy consumption divided by a production indicator, by an annual average of 1% or more in the mid- to long-term (EnMS II-Preamble). – Companies should achieve quantitative targets and adopt energy efficiency measures that are specified in the targets section of the EnMS in the mid- to long-term.
	Energy review (4.4.3) – Energy sources, use and consumption – Significant energy uses	– Specified companies must submit a periodic report annually (ECL Article 15), in which energy consumption in each business category of the company, their changes from previous year, five-year trends of energy intensity (and, in the case of non-attainment, its reason), and the list of major energy-consuming equipment (when the company has DFs) must be reported.
	– Prioritized opportunities for improvement	– (There are no explicit provisions on prioritization.) – Companies should adopt standard/target measures that are specified in the EnMS.
	Energy management action plan (4.4.6) – Responsibility – Methods to achieve and verify the improvements	– Companies should establish an organization for efficient and effective energy conservation efforts and appoint a person to be in charge of it (EnMS I-Preamble A, B). – Specified companies must nominate energy management control officers from top management, planning promoters, energy managers, and qualified energy managers (when the company has DFs) (ECL Article 7,8,9,13,17). – Companies should set policies on efforts on energy conservation, including targets on energy conservation and policies on installation and replacement of equipment (see above). – Specified companies must submit a medium- and long-term plan report annually (see above).
Do	Management responsibility (4.2) – Commitment of top management	– Control officers from top management supervise and manage the maintenance of energy consuming equipment and the improvement and monitoring of energy use of the company (ECL Article 7-2).
	– Appointment of an energy champion and an energy team	– Planning promoters support control officers (ECL Article 7-3). – Energy managers and qualified energy managers conduct maintenance of energy consuming equipment, improvement and monitoring of energy use of the company (ECL Article 7,8,9,13,17). – Control officers must respect the opinions of energy managers and qualified energy managers. Workers in specified companies must follow the instructions of energy managers and qualified energy managers when necessary (ECL Article 19-3). – Companies should establish an organization for efficient and effective energy conservation efforts and appoint a person to be in charge of it (see above).
	Competence, training and awareness (4.5.2)	– Planning promoters and energy managers must be nominated from those who completed a one-day official training course on energy management provided by the government (ECL Article 13). – Qualified energy managers must be nominated from those who have a national license on energy management (ECL Article 9, 11).
	Communication (4.5.3)	(There are no explicit provisions on communication.)
	Documentation (4.5.4)	– Specified companies must submit a periodical report and a medium- and long-term plan report annually (ECL Article 15). – Companies have to make, update and maintain documents on their energy use (EnMS I-Preamble F). – There are no explicit provisions on documentation, but the on-site survey verifies compliance with the EnMS standard through document review.
	Operational control (4.5.5)	– Companies should ensure fine-tuned energy management by facilities and equipment where technically and economically feasible (EnMS I-Preamble). – Companies should promote energy conservation by complying with the standards set in the standard section of the EnMS, most of which require them to create their own management manuals for the operation of major equipment and processes (EnMS I).
	Design (4.5.6) Procurement (4.5.7)	Companies must create their own management manuals on measures on the occasion of installing new equipment (EnMS I).
Check	Monitoring, measurement and analysis (4.6.1)	– Specified companies must monitor and analyse their energy use in periodical reports that are submitted annually (see above). – Companies must create their own management manuals on measurement, recording, maintenance and inspection (EnMS I).
	Evaluation of compliance with legal and other requirements (4.6.2)	Specified companies must evaluate and report their compliance status with the EnMS standard in their periodical Reports.
	Internal audit (4.6.3) Nonconformities, correction, corrective action and preventive action (4.6.4)	(There are no explicit provisions on these items.)
	Control of records (4.6.5)	Companies should create their own management manuals on procedures when installing new equipment (EnMS).
Action	Management review (4.7)	Companies should regularly review the implementation status of their energy conservation policy, and, if it is insufficient, take corrective actions (EnMS I-Preamble D).

Note. EnMS provisions are categorized into PDCA components by the authors.

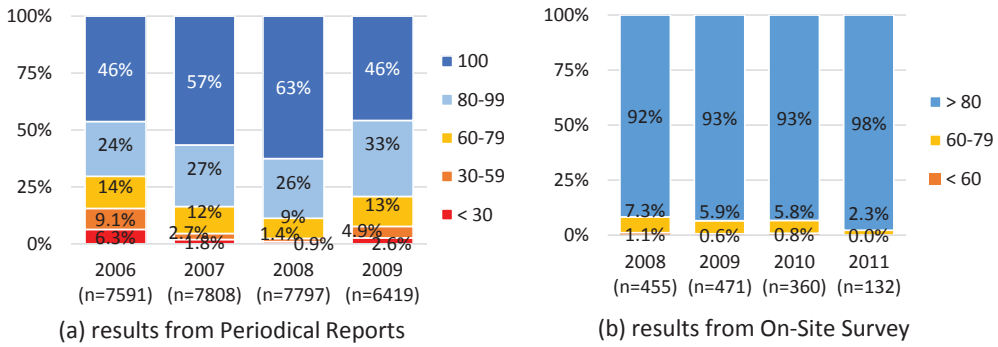

Figure 1. Distribution of compliance scores with the EnMS standard in Type-1 designated firms. Figure 1(a) shows the distribution of scores based on self-reported compliance status in companies' periodic reports and Figure 1(b) shows those based on on-site surveys (b). A perfect score is 100 points. (Source: ECCJ 2007, 2008b, 2009a, b, 2010a, b, 2011, 2012.)

tion and energy managers would check, review their EnMSs, and establish improved plans regularly. Even in the current standard, there is no requirement for internal inspections and companies are only required to self-check their compliance status with the standard in their periodical reports. It should be noted, however, that there are two other mechanisms that enhance the check process: on-site surveys as an external audit process and the quantitative targets on energy intensity improvement.

Evaluating effectiveness

In this section we evaluate the effectiveness of the energy management regulation of the ECL on the basis of a literature review, interview surveys, and a case study of a small manufacturing company.

LITERATURE REVIEW

Compliance surveys

The government of Japan annually publishes a report on compliance surveys that analyzes submitted annual reports and on-site surveys. The survey results appear mixed. On one hand, the percent of companies rated as being in complete compliance with the EnMS standard, based on self-reporting, was between 40 % and 60 % for Type-1 DFs; between 5 % to 10 % reported very low levels of compliance, a score of less than 60 on a 100-point scale (Figure 1a). On the other hand, the results of the on-site surveys, which are conducted by expert auditors, show much better compliance rates, leaving only 1 % of firms with less than a 60-point score (Figure 1b). The difference in the two results is partly caused by different rating methods, but the more important reason is that the on-site survey is meant not only for survey purposes, but also for enhancing compliance by giving "guidance and advice" to the surveyed companies. When ECCJ conducts on-site surveys, "there were many facilities that could not even submit required documents without the support of auditors and ECCJ" (ECCJ, 2012, p. 122). In fact, some auditors of on-site surveys admit that many firms do not understand the EnMS standard, nor do they have management manuals as required by the standard (ECCJ, 2012). ECCJ also stresses the importance of compliance support for firms, saying that, if the auditors did not provide any support, the compliance status would be much worse and many firms would have less than an 80-point rating, which would make them subject to inspections by the government (ECCJ, 2012, p. 124). These facts imply that, while the on-site survey plays an important role in enhancing compliance with the EnMS standard, a considerable share of the specified companies do not comply with the standard.

Compliance surveys by the government also report trends of the energy intensity of DFs (Figure 2). The energy intensity of firms can fluctuate for a variety of reasons, such as the economic downturn in 2008 that resulted from the subprime mortgage crisis in the United States, which resulted in an increase in energy intensity (see Figure 2). While the energy intensities of both sectors is on a decreasing trend overall, the improvement rate of the industrial sector does not meet the target of 1 % per year set by the EnMS standard. The improvement rate in the commercial sector seems to be on track to meet the target, although the absolute amount of energy use has been increasing (ECCJ, 2012). It is difficult to assess whether the decrease in energy intensity has been enhanced by the regulation of ECL, especially since many other countries also have experienced a similar decrease in energy intensity (e.g. Mulder and de Groot, 2011).

Econometric study

One can distinguish the impact of policy from other factors by econometric analysis. To the authors' knowledge, there has been only one such evaluation so far on the impact of the energy management regulation by the ECL. Arimura and Iwata (2007) conducted an econometric analysis by focusing on the hotel industry as an example. They tried to measure the impact of tightened regulation in 2002, which "upgraded" Type-2 DFs in the commercial sector to Type-1 DFs.[5] Based on an analysis of panel data on 142 DFs in the hotel industry, they estimated

5. Before the 2002 amendment to the ECL, commercial facilities were designated as Type-2 DFs even if they consumed more than 3,000 kL of crude oil equivalent per year. At that time Type-2 DFs were not required to submit annual reports.

that the tightening of regulation in 2002 decreased fuel consumption by 2.8 % and fuel intensity by 2.4 % from 2002 to 2004, after controlling for weather conditions and other facility characteristics. Though this is a highly valuable study which quantified the impact of the regulation, it deals with the impact in only one commercial sector caused by one amendment to the regulatory scheme, thus making it difficult to extrapolate to the broader impact of the regulation.

INTERVIEW SURVEYS WITH SPECIFIED COMPANIES

Here, we summarize the major results of interview surveys conducted with specified companies in 2009 and 2010. The survey sample includes 12 manufacturing companies, and the results are detailed in Kimura and Noda (2010), as well as two companies from the commercial sector. We asked the companies how each component of energy management regulation in the ECL was working.

In our interviews, many comments were made, even by large companies, on the positive impact of the energy management regulation in the ECL. Examples of positive feedback are as follows.

- "The requirement to have qualified energy managers was important because acquiring the qualification was an enhancement for engineers and gave them the opportunity for basic training" (Company I, non-ferrous metal).
- "The target to improve energy intensity by 1 % annually has a positive impact because it helps us to persuade top management to make energy efficiency investments" (Company C, paper and pulp).
- "Establishment of the ECL increased general awareness toward energy conservation" (Company E, electronics).
- "We have ISO 14001 certification, and the energy conservation target is based on the energy intensity improvement target set in the ECL. Thus, the ECL provides us a useful reference target" (Company G, food).
- "The mandatory reporting of energy use had an important impact because it made our recording of energy use more precise, and circulating the analyzed data within the company increased awareness about energy conservation" (Company H, food).
- "Designation as a DF enhanced our energy conservation activities. It was after the designation that we established an EnMS" (Company I, non-ferrous metal).
- "The amendment to the ECL in 2008 was an important stimulus for us to intensify our energy conservation activity. We have hundreds of small stores which, in the past, were not a major focus for our energy conservation activity. However, as the 2008 amendment required us to cover such small stores as part of our group, we started collecting energy data on all the stores we have. Based on such data we began to survey how much we can reduce usage and by what measures" (Company M, retail).
- "Specification as an SBO under the 2008 amendment to the ECL made us more conscious about energy conservation and compliance with the regulation. From 2007, a year before the amendment, company headquarters started our first project on energy conservation, trying to establish best practices in a couple of stores and then to spread the methods to hundreds of other stores" (Company N, amusement).

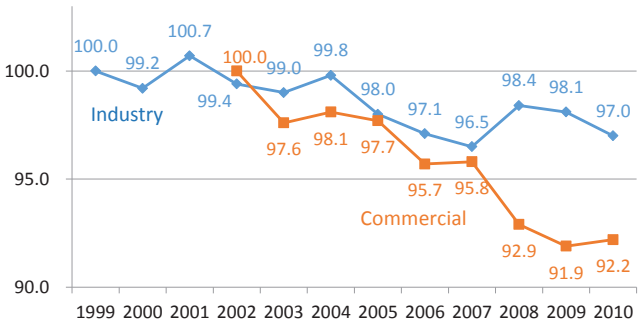

Figure 2. Trends in reported energy intensity of DFs by sector, 1999–2010. The graph shows the average energy intensity of DFs reported in periodic reports, weighted by the amount of energy use. Results are indexed (base = 100) to the 1999 level for the industrial sector and the 2002 level for the commercial sector. (Source: ECCJ 2012.)

Interviewed SMEs (Companies J, K, and L) also noted positive impacts of the regulation, as follows.

- "We have made energy efficiency investments for several years based on our medium- and long-term plan report. It helps me persuade top management to make investments if it is required by law" (Company J, automobile components).
- "The medium- and long-term plan report is a kind of pressure for us. It encourages us to make a longer-term plan of investment" (Company L, automobile components).
- "After being designated as a Type-1 DF, we started to look for possible ways to pursue energy conservation, even if they are small, such as stopping small pumps on the weekends. We also revised our operation manuals for ladles to reduce their preheating time. We have to accumulate such various measures in order to achieve the target of 1 % improvement in energy intensity" (Company K, automobile components).

On the other hand, some comments also implied that the regulations were ineffective. One line of argument, which was made by large companies, especially in energy-intensive industries, is that the regulation had little impact on their energy management because the EnMS required by the ECL is very basic and can be met with no additional effort. Some examples are as follows.

- "The EnMS standard of the ECL prescribes just "ordinary" practices that our company and industry have already been implementing. Our management standards are more detailed than the EnMS standard required by the ECL" (Company A, cement).
- "We recognize the EnMS standard as a compilation of energy conservation measures that were already adopted in major companies. Our company is implementing more advanced measures" (Company C, paper and pulp).

- "The major motivation for energy conservation was the reduction of energy costs; the role the regulation was very limited" (Company B, paper and pulp).
- "Reporting energy costs and consumption has already been our practice since early times. The annual reporting mandated by the ECL is just aggregating our existing data" (Company F, electronics).

Another problem noted by interviewed companies was that the EnMS introduced by the regulation or the EnMS standard itself did not always work to induce tangible energy conservation measures. For example,

- "Managers in our facility department are not aware of the EnMS standard, expect for the qualified energy managers. Because of this, it is often the case that they purchase cheaper equipment based on the proposals of suppliers and do not consider products with higher efficiency" (Company I, nonferrous metal).
- "While we have our medium- and long-term plan, we have to take every factor other than energy conservation into consideration when making investment decisions. It is difficult to consider the medium- and long-term plan very much" (Company C, paper and pulp).
- "Although we have our medium- and long-term plan, quality and safety are the top priorities for our investment. We have to say that energy efficiency has a low priority" (Company G, food).
- "We try to achieve the energy intensity improvement target because it is the law. However, as it is a nonbinding target, we are not desperate to achieve it" (Company F, electronics).
- "We do not care very much about the energy intensity improvement target because we just have to explain the reason, even if we fail to achieve it" (Company G, food).

From the results of the interviews, four implications can be drawn. First, it is evident that the energy management regulation in the ECL has had a positive impact generally in increasing awareness and establishing basic EnMSs in specified companies. Even large companies that have already begun some energy conservation efforts admitted that, together with other factors such as cost reduction and corporate social responsibility (CSR), the regulation in the ECL was an important stimulus for enhanced conservation efforts. Second, because the regulation in the ECL is meant to be applied to a broad range of companies, the requirements may be too basic to have a meaningful impact on large, energy-intensive companies that already have very high levels of energy management due to cost concerns. However, third, it should be noted that there are some companies that were not very conscious about energy conservation previously but that became more conscious and started energy conservation activities after designation under the ECL. Such companies include those in non-energy intensive industries, as well as SMEs. Fourth, there seem to be some cases in which the EnMSs introduced under the regulation or the EnMS standard itself are not always effective at inducing tangible energy conservation measures.

A CASE STUDY OF A MANUFACTURING SME

We present a case study of Company J, a manufacturing SME. The reason to conduct this case study is that we expect that SMEs have more problems confronting energy management and related regulation. The case is meant to highlight how the ECL regulation would work or do not work in such companies in greater detail. Thus, we conducted a site tour, interviews, and a document survey in 2009 with the full cooperation of the company.

Company J is a forging manufacturing company with about 150 employees that produces automotive components. It has three locations in Japan, one of which has been designated as a Type-1 DF since the 1980s. The DF consumes about 5,000 kL of crude oil equivalent of energy per year on average. Its major equipment includes electric induction furnaces, gas furnaces, and forging press machines.

According to the regulation of the ECL, the company has nominated one qualified energy manager in their facilities management division and conducted annual reporting since the 1980s. The company set up a committee on energy conservation in 1997 when the energy intensity improvement target was introduced to the EnMS standard. However, the energy manager admitted that the committee was not very active. While the committee set their target as a 1 % improvement of energy intensity based on the EnMS standard, they did not have a concrete plan to achieve it. They have made energy efficiency investments, such as adoption of variable speed drives, but they could not improve their energy intensity, which was increasing due to changes in the production mix (Figure 3). Furthermore, the company had great difficulty in complying with the EnMS standard. In fact, the company's compliance status with the standard was not good, and the company was advised by the government to improve the situation in 2007.

Company J was subject to an on-site survey by the government in 2009. To show compliance with the EnMS standard in the survey, the company decided to hire an energy consultant because it was very difficult for the company to understand the EnMS standard and develop the management manuals required under the regulation by themselves. The company also had difficulty in explaining its increasing energy intensity in 2007 and 2008. They realised that it was influenced by their production mix and operation rate, but they had not conducted quantitative analysis. It took a couple of months for them to prepare the documents that were required for the survey. It should be noted that, while they took great efforts to arrange the required documents, they left their investment plan unchanged and took no additional energy conservation measures. On the survey, the company successfully showed their compliance with the EnMS standard and received a score of 97 out of 100.

This case study has three important implications. First, it shows that the on-site survey plays a very important role in enhancing compliance with the EnMS standard. Second, it also shows that some firms lack the capacity to comply with it by themselves. Such firms cannot understand the EnMS standard, nor can they develop management manuals by themselves. Third, such companies may not be able to make use of the EnMSs adopted to comply with the regulation. In the case of Company J, it is quite doubtful that they make use of the management manuals or the analysis of energy data that they managed to prepare for the survey. This implies that improve-

ments in compliance with the regulation from the on-site survey could be primarily a "paperwork" improvement and not actually promote tangible energy conservation measures.

Concluding discussions

EFFECTIVENESS OF THE ENERGY MANAGEMENT REGULATION

Based on the literature review and interview surveys, first, it would be fair to conclude that the impact of the regulation in the ECL was evident. It was observed that some interviewed companies clearly admitted that the regulation increased awareness of energy conservation within the companies and that it enhanced the adoption of basic EnMSs through measures such as the appointment of responsible managers, establishment of responsible organizations, and implementation of basic energy data analysis. Although the sample size for our interviews is quite limited, it would be safe to say that many companies have enacted similar mechanisms under the regulation.

However, such positive comments from interviewed companies were all qualitative, and we are not sure how much of an impact the regulation has on actual energy consumption. Arimura and Iwata (2007) observed a 2–3 % improvement in the hotel industry following the 2002 amendment, but this finding should not be extrapolated to other industries or to other periods because of the wide variation in industries and other amendments adopted over this time. Also, the decrease in energy intensity of DFs shown in Figure 2 is not large when compared with those experienced in other countries (e.g., Mulder and de Groot, 2011), implying that the additional impact of the regulation in improving energy intensity might be limited.

Second, it can be concluded that the impact of the regulation depends on firm characteristics. From our interview surveys and the case study of an SME, two factors seem to have a significant effect on how companies perceive or react to the regulation: (1) salience of energy use and (2) organizational capacity (Figure 4). Salience of energy use can be roughly indexed by energy cost share; organizational capacity by company size. If a company has both a high salience of energy use and sufficient capacity (i.e., the first quadrant of Figure 4), it can be assumed that the company has already established a good EnMS, even without regulation like the ECL. Large, energy-intensive companies are categorized in this quadrant. Even without the regulation, they have strong incentives to reduce energy use because it is one of the major cost factors. In fact, such companies in our interviews did not view the regulation as important because the requirements were too basic. On the other hand, companies that have sufficient capacity but low salience of energy use (i.e., the second quadrant of Figure 4) may not have made great efforts in energy efficiency previously. However, with regulation, they are able to make substantial progress when they have a proper stimulus and guidance. Our interview surveys show that the regulation stimulated energy conservation activity in large companies in the commercial sector that have many small locations and did not pay much attention to energy conservation in those locations before they became regulated. A couple of large manufacturing companies (e.g., Companies G and I) also had similar responses in our interviews.

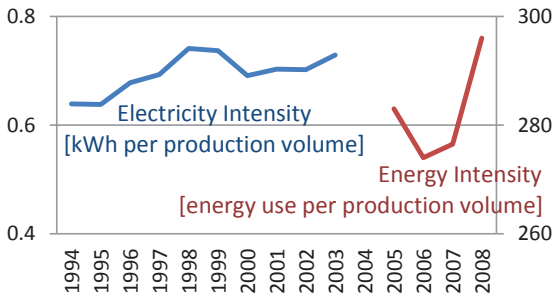

Figure 3. Energy intensity of Company J, 1994–2008. Energy intensity in 2005–2008 uses a different index from that in 1994–2003. 2004 data are missing (Source: Periodical Reports of Company J).

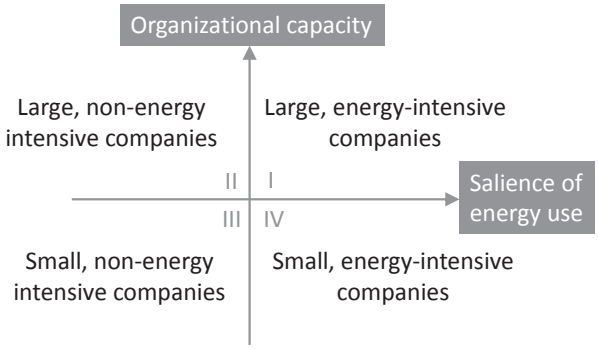

Figure 4. Categorization of companies by salience of energy use and organizational capacity.

Companies without sufficient capacity (i.e., the third and fourth quadrants) have more difficulty. Many SMEs can be categorized here. They have difficulty not only in complying with the regulation, but also in making use of the adopted EnMS because they lack capacity. In such cases, complying with the EnMS standard could indicate mere "paperwork" compliance, as was observed in the case study of Company J. It should be noted that there are some SMEs that have sufficient capacity to take advantage of the regulation, of course. A notable example of such an SME is Company K, which worked not only on preparing documents but also on promoting tangible conservation measures on the basis of the adopted EnMS. We assume that the progress in Company K was possible because the company has been active in *kaizen* (continuous improvement) and total production maintenance (TPM), and thus had sufficient organizational capacity. The problem of insufficient capacity seems to be exacerbated by a couple features of the EnMS required in the ECL. We addressed these issues in the section "Comparison of the ECL with ISO 50001". One such feature is that the standard is created as a common standard for all commercial facilities and all industrial factories (see Table 1). This makes its provisions very abstract and generalized, and thus difficult to understand. Another problem is the emphasis on management manuals. Standardization of operations by using manuals is an effective way of increasing

productivity and efficiency, and large companies are often accustomed to it. On the other hand, many SMEs are not familiar with the use of such manuals.

How are specified companies distributed among the four categories in Figure 4? Although additional research is needed to make such quantitative estimation, from our discussion with several energy auditors who have extensive knowledge on the status of energy management in Japanese companies we suspect that the majority of specified companies fall into the third quadrant (small, non-energy intensive companies). This view is also supported by ECCJ (2012) (see "Literature review" above) and by the fact that the proportion of specified companies among SMEs is expected to be high (more than 30 %).

IMPLICATIONS

The Japanese case shows that EnMS regulation can play an important role in promoting the establishment of basic EnMSs in regulated companies. However, as our analysis indicates, companies whose energy conservation measures are accelerated by such a regulation may be limited to those companies that have sufficient organizational capacity, but with low enough salience of energy use to have not implemented EnMSs prior to regulation. This is because an EnMS approach is effective for continued improvement in energy management, but it also requires organizational capacity to develop, customize, and make use of an EnMS. In addition, companies with both the organizational capacity and high salience of energy use are likely to have already developed their own EnMSs, even without regulation. In companies without sufficient organizational capacity, which we assume are the majority of firms in the case of Japan, regulation may not be effective in inducing tangible energy efficiency activities beyond the mere formality of compliance with the regulation on paper.

Our analysis indicates that public programmes to enhance EnMSs in smaller companies should address this capacity problem. One option is to provide support to companies for capacity building. In the case of the regulation in the ECL, the on-site survey can be a good opportunity to supplement the regulation by supporting companies lacking in organizational capacity. Although the supportive dimension of the on-site survey is already recognized in practice (ECCJ, 2012), we think it should be reorganized into a more explicitly support-oriented programme, rather than as only a system for verification of compliance.[6]

Another way to address the capacity problem is to give advice on concrete measures to achieve energy conservation, rather than to support building an EnMS. As we discussed in the Japanese case, smaller companies are not accustomed to a management system approach. In such cases, specified, targeted, and customized information on measures that may be adopted would be more effective. Energy audits and consultation for individual firms would be an extreme approach (Figure 5). Because of the range of organizational capacities of companies, selection of a single approach is not necessarily required, but rather, a combination of approaches should be pursued for different market segments and sectors.

6. Such an approach has also been recommended in other areas of regulation such as food safety (Fairman and Yapp, 2005).

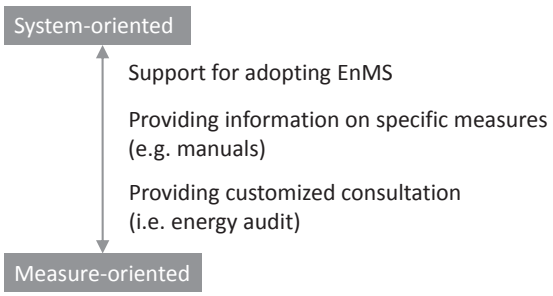

Figure 5. Types of measures to support energy management in the industrial and commercial sectors.

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Endnotes

The description and English translation of legal provisions in the Energy Conservation Law in Japan in this paper have been prepared by the authors and are not an official version. The views expressed in this paper are solely those of the authors and do not reflect the views of any organizations. This paper is based on Kimura and Noda (2010), a report published in Japanese, with substantial addition of data and analysis.

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