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Considerations of the effects of combination and future needs of international standards related energy efficiency and management in industrial fields

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Abstract: Many international standards related to energy management have been published by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). These standards were developed separately by different technical committees within ISO and IEC, but organizations refer to them in combination. This paper introduces these international standards and presents application cases from some organizations. Recently, in addition to energy management, organizations have been required to address carbon management as actions against global warming. In response to this situation, some international standards related energy management and efficiency are being mentioning carbon management. This paper describes considerations for future international standards.

Keywords: Energy management, carbon management, FEMS, International standards

1. INTRODUCTION

Global warming is a significant issue that needs to be addressed. The push for sustainable business practices requires many organizations to undertake activities to improve their energy efficiency and reduce their greenhouse gas (GHG) emissions. To support these activities, many international standards related to energy efficiency and management have been published. This report describes the international standards related them available in industry sectors and future needs.

2. ISSUES OF ENERGY MANAGEMENT ACTIVITIES IN INDUSTRILAL FIELDS

2.1 Requests for activities against global warming

According to the International Energy Agency (IEA) report, about 40% of greenhouse gas emissions from the end-user perspective come from the industrial field [1]. To combat global warming, many companies are being asked to improve their energy efficiency and switch some of their energy consumption to renewable energy.

These requirements can disrupt factory operations due to costs and complicated energy supply issues. The output of renewable energy generation is intermittent and dependent on weather conditions, and the price of electricity generated from renewable sources is higher than that from fossil fuels. In addition, the type of energy often changes during the process, such as heavy fuel oil being converted to electricity, steam, or compressed air, making the energy flow in industrial field too complicated to track.

2.2 Actions depend on individual skills

In many industrial fields, energy performance improvement actions have been considered and implemented based on the experience of their energy managers. In these cases, when the manager changes, their policy of energy management may be also changed. Actions against global warming require long-term commitment, and it is difficult to meet these requirements under such circumstances.

2.3 Actions with retrofitting industrial facilities

In Japan, retrofitting facilities with new ones was a major action for improving energy performance. As a result, energy efficiency of new facilities has been improved, making retrofitting an effective way to enhance a factory's energy efficiency. That is the time elapsed since the introduction of the facility is a key factor for improvement. If the retrofit is recent, the improvement is small. If an organization has already retrofitted most of its facilities, this method is not effective as a next measure in most cases because the effect of further retrofitting is small and the return on investment does not meet management decisions.

2.4 Actions with reviewing facilities operation

Instead of the retrofitting facilities, actions focused on the optimized operation of facilities are gaining attention. For example, the Japan Electronic Information and Technology Association (JEITA) promotes RENKEI control [2]. In RENKEI control, constraints such as productivity, delivery date, production volume, and energy cost are listed and prioritized, and the operation of facilities is optimized to minimize the energy consumption according to these prioritized constraints. Compared with the retrofitting facilities, implementing the RENKEI control is lower cost because the investment mainly involves customizing control systems of targeted facilities. The concept of the RENKEI control can be adapted from some facilities to entire factories and multiple organizations' operations. If the number of targeted facilities is large, a specific calculation system called industrial facility energy management system (FEMS) is used for data collection and optimization of operation and production plans.

3. INTERNATIONAL STANDARDS

3.1 Technical committees in ISO and IEC

ISO and IEC are organizations that develop international standards. Each technical committee (TC)

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under the umbrella of ISO and IEC defines the scope to determine the fields in which the TCs will develop international standards. This section introduces the activities of some TCs related to energy efficiency and management.

3.2 Organizational structure

ISO TC301 (Energy management system and energy savings) is developing international standards on how to manage and improve organizations' energy performance. For example, ISO 50001 defines the requirements for organizational structure in energy management system (EnMS) [3]. Some international standards include specific requirements. For instance, ISO 50006 defines a method for evaluating energy performance using energy performance indicators and baselines [4]. ISO 50047 outlines a method for calculating energy savings by comparing conditions before and after, or with and without energy performance improvement actions [5]. JEITA proposed and led discussions on assessing energy management progress, resulting in ISO TS 50011 [6][7]. Additionally, an international standard for managing carbon emissions from scope 1 and scope 2 under EnMS is being developed as ISO 50100 [8].

3.3 Industrial-process

IEC TC65 (Industrial-process measurement, control, and automation) is developing international standards on how to control industrial processes. Under IEC TC65, many working groups (WGs) and joint working groups (JWGs) are established, including JWG14 (energy efficiency) and JWG17 (information exchange between energy systems).

In JWG14, IEC 63376 defines functions and information flow in FEMS. This standard is expected to lower the barriers to FEMS implementation [9][10].

In JWG17, IEC TS 62872-1 describes use-cases for information exchange between smart grids and factories/plants [11][12]. These use-cases involve the exchange of information about the volume and timing of power demand, supply, and power conditioning between factories/plants and smart grids. This international standard is expected to help determine information protocols and actions between energy demand and facility operation with FEMS.

4. UTILIZATION OF EXISTING INTERNATIONAL STANDARDS

4.1 General

Each international standard is developed separately, but organizations, including factories, use them in combination. This section describes some examples of their utilization.

4.2 Energy performance improvement actions

As described above, the requirements related to organizational structure are determined in ISO 50001. And related standards of it, such as methods to measure energy performance and calculate energy savings, are also published. Organizations are primarily required to check ISO 50001 and refer to related standards as needed.

When planning energy performance improvement actions, energy managers need to understand their energy use and collect necessary data. This involves using power bills and meters to gather data on energy consumption, which is vulnerable to changes in the environment and production activities. Therefore, energy managers must collect not only energy consumption data but also relevant data such as temperature and production information. Data collection systems called FEMS are used for this purpose. Several types of FEMS are available on the market. IEC 63376 defines the classification of FEMS, allowing factories to select or build FEMS according to their requirements.

After data collection, evaluation and calculation methods for energy performance and energy savings are defined in ISO 50006 and ISO 50047. Using data collected in FEMS, energy managers can estimate expected energy savings before implementing actions and evaluate energy savings after implementation.

4.3 Optimizing operation and production plans

In production activities, operators need to consider several factors such as delivery dates, productivity, and product quality. Energy efficiency is included in cost considerations, and one effect of improving energy efficiency is cost reduction. Recently, due to sustainability management, GHG emissions from products have also been added to these factors. Specifically, Scope 1 and Scope 2 GHG emissions can be reduced through each organization's efforts.

Actions for reducing GHG emissions include improving energy efficiency and switching to renewable energy. From a cost perspective, switching to renewable energy increases costs. Therefore, energy managers are required to manage both energy performance and GHG emissions. However, the cost benefits and drawbacks may be opposite. For example, the price of power generated from renewable energy may be higher than that from fossil fuels. In factories that have already implemented energy efficiency improvement activities, the effect of further energy efficiency improvements is lower than the effect of switching to renewable energy. As a result, the cost of purchasing power increases, and the cost-cutting effect is less significant for these factories.

Due to the increased demand for renewable energy, wind turbines and solar photovoltaic systems connected to the grid have increased. The outputs of these systems vary with weather conditions. To maintain power quality, such as voltage and frequency, power companies need to balance energy supply and demand. One method of balancing is information exchange between the power grid and the energy demand side, adjusting power supply and demand. This is called "Demand Response."

Factories are significant power consumers, and some have their own power generation systems and/or battery systems. By sending energy demands and operating facilities for balancing, factories can play a significant role in demand response. IEC 62872-1 describes use-cases related to demand response. FEMS, as defined in

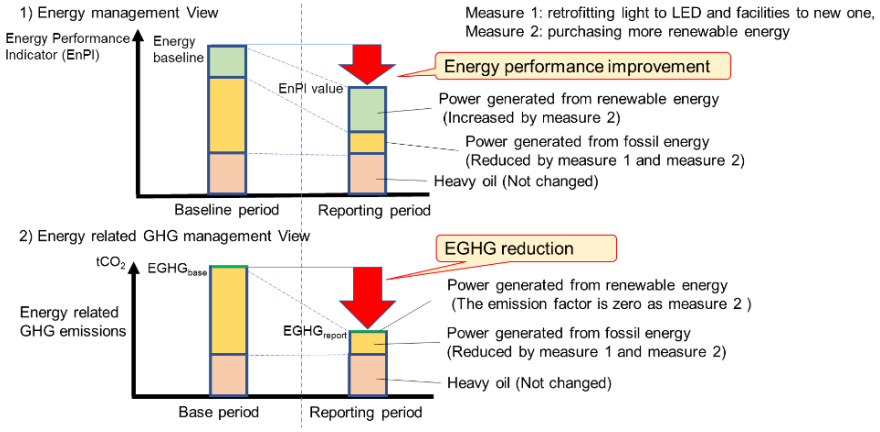

Fig.1 An example of improving energy performance and reducing GHG emissions

IEC 63376, can create facility operation plans based on the information exchanged between them.

5. CONSIDERATION OF NEXT INTERNATIONAL STANDARDS RELEATED ENERGY EFFICIENCY AND MANAGEMENT

5.1 General

Now, methodologies for calculating and management GHG emissions are discussed, and the international standards are developing. And more international standard related industrial facility operation to treating to reduce GHG emission from industrial field. In this section, some considerations about items for future proposed international standards will be decreased.

5.2 FEMS for automated whole optimization

Described above, factories have big space to improve their energy efficiency utilizing renewable energy and adjusting power demand and supply. To treating them, energy managers and operators are requested to handle too many constraints simultaneously. In the case, targeted facilities and management systems of the managements might be too complex to control by operator.

For this, FEMS is requested to optimize whole facility operation and product plans. IEC 63376 defines only function of FEMS. So, FEMS optimized to facility operation and production plans automatically is needed. For this, data format applied for whole optimization is needed to standardize. As the first step, collecting use-case of automized optimization such as using Artificial Intelligence (AI) will be collected. After that common items related data-format and operation will be discussed.

Furthermore, to realize the FEMS, it might be difficult to construct one computer system. So, the FEMS might be constructed with multiple systems, The structure and role of each system should be standardized.

5.3 GHG emission management

Almost factories have been requested to improve their energy efficiency. Recently, almost country set targets for reducing GHG emission. Industrial fields emit huge GHG and will be requested to put to reduce the GHG emission in work.

Improving energy efficiency and switching power resource to renewable energy are action to reduce GHG emissions. Former leads to reduce energy consumption. That is, GHG emissions generated in energy conversion such as fossil to power, are decreased by the reduction. The latter leads to change energy resources which emits GHG in the process of energy conversion. So, they are understood similar way as reducing GHG emission, but the effect is different. Fig 1 shows an example of the effects of the measures. Switching to green power as measure 1 in the figure makes their GHG emission reduced, but their energy efficiency is not changed. If measure makes fossil power consumption reduced as the measure 2, their GHG emission is reduced, and their energy performance is improved.

To sustain activities in industrial fields, factories are requested to manage their energy efficiency, GHG emissions and energy cost. In the case, concept of the RENKEI control will be helped for the industrial operation. And there are some cases in that switching part of an organization's purchased power to green power might make their energy efficiency worsen. For this, top management of the organization will be requested to decide to allow to reduce their GHG emission with worsen their energy efficiency.

For top management decision-making, information on energy efficiency and GHG emissions in each situation is essential. FEMS is required to monitor and collect data, optimize facility operation plans, and manage production plans accordingly. Therefore, international standards for FEMS that define processes and data to meet these requirements are necessary.

5.4 Sharing energy and GHG emission information

In carbon management within the supply chain, managing GHG emissions categorized three scopes. Scope 1 is a GHG which an organization emits directly in their product and combustion of fuel. Scope 2 is a GHG which is emitted in process converting energy purchased by the organization. Scope 3, which are not directly emitted, is also required. Scope 3 includes GHG emissions before and after production, such as producing parts purchased from other organizations,

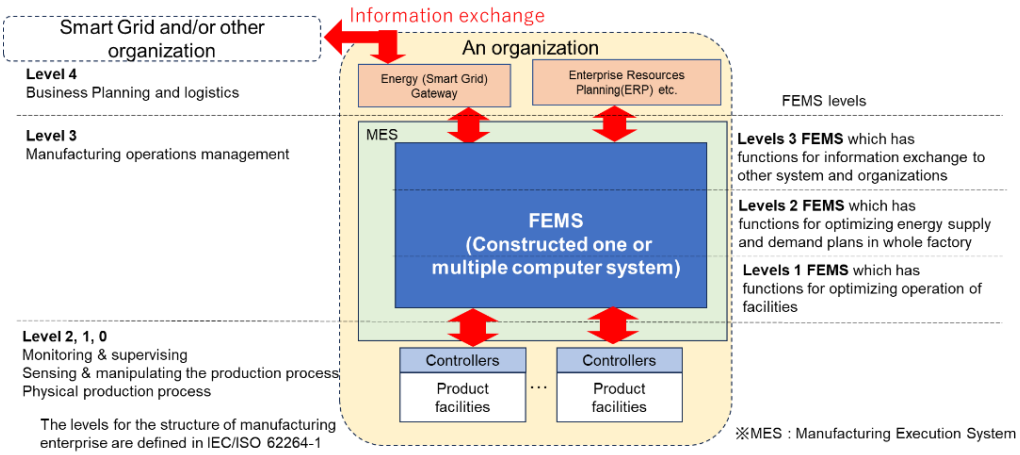

Fig.2 A concept of FEMS structure for industrial facility management

transferring materials, using, and discarding products. The scope of management includes not only factories but also material and parts suppliers and consumers, making it too wide to collect data manually.

Therefore, FEMS is required to collect and to send data of the scope 1 and 2. In industrial fields, it is considered that FEMS specializing in information exchange will respond. Thus, an international standard related to the data structure for FEMS specializing in information exchange will be needed.

5.5 FEMS structure

As described above, the role of FEMS in energy management and carbon management will increase. The data that FEMS collects, calculates, and optimizes will be too complexity for a single FEMS system. Therefore, in real industrial operations, FEMS constructed with multiple FEMS systems will be needed to handle them. Fig.2 describes one of the concepts of combining multiple FEMS. In the concept, the FEMS positioned level 3 is specialized in information exchange to other systems. The FEMS positioned level 2 specialized to optimize to energy supply and demand in whole factory with using information exchanged the FEMs in level 3. And the FESMS positioned level 1 is specialized to optimize to the operation of facilities according to the production and facility operation plans optimized in the FEMS in level 2. Since to handle energy management and Scope 1 and 2 GHG emission is complicated for single FEMS, collaboration of concept the multiple FEMS are needed. This concept is described only in factory, but this concept may be expanded to multiple factories and community.

6. CONCLUSION

In this paper, published international standards related to energy efficiency and management in industrial fields and the effects of their combination were introduced. Considerations about future needs for international standards to meet energy and carbon management requirements were also discussed. The FEMS-TF of Japan Electronics and Information Technology Industries Association (JEITA) control and energy management commeettee is discussing the FEMS structure and the items described in this document.

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