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Development of Energy-FMEA for Energy Review of ISO 50001 Energy Management System

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This paper is to develop Energy-FMEA for Energy Review of ISO 50001 Energy Management System. Energy Review is the core requirement of ISO 50001. This study develop Energy-FMEA and suggest Energy Review Inventory and Assessment Criteria for performing Energy-FMEA. Also, it shows case study to verify whether to proper.

Keywords: Energy-FMEA, En-FMEA, Energy Review, ISO 50001, Energy Management System

1. Introduction

It is faced with a problem of rising energy prices and global warming due to continuous high oil prices and the exhaustion of fossil fuels, and the number of studies on energy resource development and new renewable energy has been increased steadily in response to the problem. However, it is difficult to meet constantly growing energy needs only by expanding energy supply. As a human survival crisis is on the way due to such an energy problem, energy management is recognized as a task that must be solved, and the ISO 50001 Energy Management System was published as an international standard in 2011. ISO 50001 is a standard intended for lowering energy costs and improve energy efficiency by managing energy systematically (ISO, 2011). Currently, the implementation of ISO 50001 Energy Management System is under way, and attempts to save energy and improve efficiency are being made mainly by large companies at home as well as abroad. The key to the ISO 50001 Energy Management System is Energy Review. It could systematically establish directions and manage goals for energy improvement through energy review. Because there is no systematic methodology for energy examination despite this importance of energy examination, energy examination items to be improved are not properly understood, so a lot of important energy examination items have been missed.

This paper would like to suggest an energy examination methodology applying FMEA for efficiently pushing ahead the ISO 50001 Energy Management System recently being concerned greatly by companies, and to be a practical help to energy improvement activities through a relevant case.

The introduction suggested reasons why Energy-FMEA (En-FMEA) should be needed and implemented. Section 2 reviewed Environmental-FMEA (E-FMEA) and Section 3 developed En-FMEA and suggested proceedings of En-FMEA in reference to E-FMEA. Section 4 appeared case study for validity of developed En-FMEA.

2. Review of Environmental-FMEA (E-FMEA)

ISO 14001 and ISO 50001 are standards on management activities in the field of environment and energy, respectively, and environment is closely associated with energy. It is because the effect on environment also increases as energy use increases rapidly. Looking into the outline of requirements including ISO 50001 : 2011 Energy Management System-guideline to use, it describes that ISO 50001 is intended to reduce greenhouse gas emissions, energy cost and other related environmental effects through systematic energy management. Like this, ISO 14001 and ISO 50001 have a common goal.

E-FMEA (Environmental Failure Mode and Effect Analysis) is a new DfE (Design for Environment) method developed for using at an initial stage of product design (Bae, Cha, Kim, and Jang, 2013). The FMEA technique is a method to evaluate possi-

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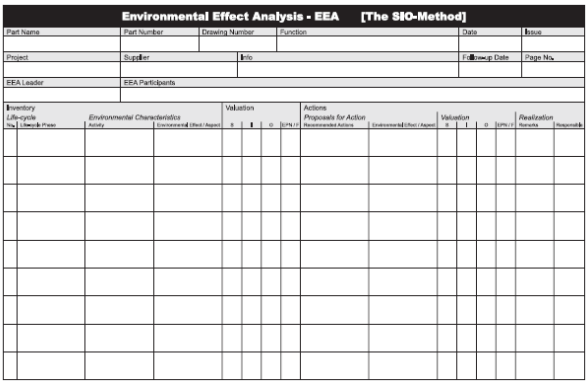
ble potential failure modes and their effects, and to systematically approach by using a table for preventing failure, which was first used in the Apollo launch plan that is aerospace engineering in the mid 1960s, and the U.S. Navy had established and used MIL-STD-1629 as a standard on FMEA application in 1974 (Ford Design Institute, 2000). E-FMEA is divided into three types such as Lindahl's, Ford's and Zackrisson's E-FMEAs. Of them, Zackrisson's E-FMEA is a method to do environmental side analysis in the ISO 14001 Environmental Management System.

2.1. E-FMEA of Lindahl

In Lindahl's E-FMEA, classification of a product list is divided into product processes, activities, environmental effects and influences. A methodology and criterion for classification of a product list is not suggested, and is determined subjectively for environmental effects and influences by developers. In addition, if divided into environmental effects and influences, it is difficult to find cause and failure modes for improvement(Lindahl and Tingstrom, 2000). <Figure 1> is E-FMEA form of Lindahl.



〈Figure 1〉 E-FMEA form of Lindahl

Also, <Table 1> and <Table 2> are assessment method and criteria of Lindahl for E-FMEA (Lindahl and Tingstrom, 2000).

〈Table 1〉 Assessment method of Lindahl

Assessment	Assessment Item	Assessment Method
SIO	Controlling documents (S) Public image (I) Environmental consequences (O) Improvement possibility (F)	SIO (1~3) EPN = S + I + O (Maximum = 9) SIO (1~9) EPN = S + I + O (Maximum = 27)
KEE	Customer demands (k) Internal demands (i) Authority demands (l) Public demands (a) Quantity (m) Seriousness (s) Modification cost (kf) Improvement possibility (p)	KEE EPN = K + E + F (Maximum = 30) K = (k + i + l + a) · 2 (Maximum = 12) E = m · s (Maximum = 9) F = kf · p (Maximum = 9)
ULF	Local level (L) Regional level (R) Global level (G) Seriousness (A) Risk of effect on the biosphere (B) Range of time (O) Quantity (M) Improvement possibility (F)	ULF EPN = L + R + G + A + B + O + M (Maximum = 31)
IVF	Demand / Desire (K / Ö) Quantity / Relative amount (K / M) Control / Influence possibility (K / P)	IVF PN = (K / Ö) · (K / M) · (K / P) (Maximum = 1000)

<Table 2> Assessment Criteria of Lindahl

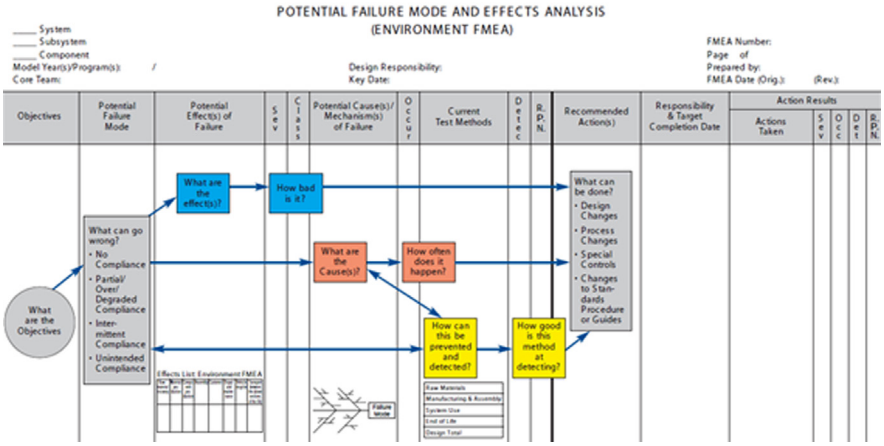
Controlling documents S (1~3)	
1	No requirements, environmental policy or law cover the referred environmental effect.
2	The environmental effect will, in the near future, be regulated either by law, managing documents or an environmental policy of the company itself.
3	The environmental effect is regulated by law or managing documents and/or runs against the environmental policy of the company.
Public image I (1~3)	
1	Has no negative influence on the environmental reputation of the company.
2	Has no direct negative influence on the environmental reputation of the company but might affect the public opinion indirectly.
3	Has serious negative effects on the public opinion of the environmental reputation of the company.
Environmental consequences O (1~3)	
1	No negative environmental influence lies within the field for which the EEA-team has the competence to judge.
2	Negative environmental influence is short-term and the probability for recovery is good, or of long duration but of less importance.
3	Negative environmental influence is of the kind, degree and extent that might cause long-term or permanent damage to the environment.
Improvement possibility F (1~9)	
1	No improvement possibility.
2~3	Small improvement possibility.
4~6	Some improvement possibility.
7~8	Large improvement possibility.
9	Very large improvement possibility.

2.2 E-FMEA of Ford

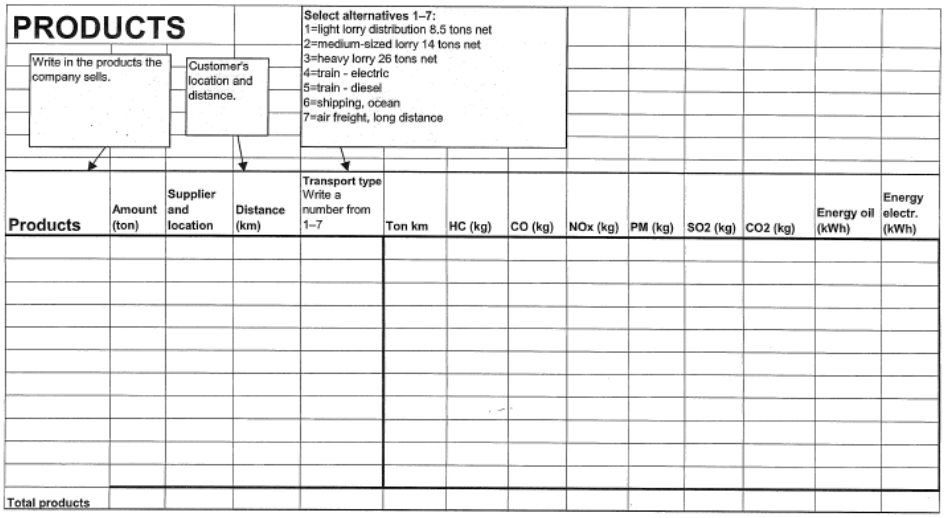
In Ford's E-FMEA, classification of a product list is divided into goals, potential failure modes, failure's potential influences, causes/mechanism of potential failures and current test methods. It could evaluate numerical values and results on environmental influences, but does not analyze modes and causes/mechanism. <Figure 2> is E-FMEA form of Ford (Bae, 2014).

2.3 E-FMEA of Zackrisson

In Zackrisson's E-FMEA, classification of a product list is divided into activity separation, quantity/flow, environmental side, quantity/influences and ELU (environmental loading unit



<Figure 2> E-FMEA form of Ford



〈Figure 3〉 E–FMEA form of Zackrisson

designated to calculate environmental influences), and analysis is carried out only in terms of environmental side and influences like Lindahl's E-FMEA. <Figure 3> is Zackrisson's E-FMEA form (Zackrisson, Bengtsson and Norberg, 2004).

3. Development of Energy-FMEA (En-FMEA)

ISO 14001 Environmental Management System have many similarities with ISO 50001 Energy Management system, but an ISO 50001's crucial difference from ISO 14001 in companies is that its improvement result is changed into economic values. This is a reason why companies should pay more attention to ISO 50001 Energy Management System. It is difficult to apply the existing E-FMEA to ISO 50001 Energy Management System. It is because a product list suitable for the Energy Management System should be prepared and the economic aspect should also be considered even though ISO 14001 Environmental Management System and ISO 50001 Energy Management System have many similarities. En-FMEA enables ISO 50001 Energy Management System to systematically establish directions and manage goals for energy improvement through energy review.

Therefore, in Section 3, it would like to develop Energy-FMEA (hereafter, En-FMEA) for examining energy in ISO 50001 Energy Management System.

3.1 Inventory Classification for Energy Review

This study classified with Activity(or Process), Facility, Energy Source, Energy Usage, Energy Aspect, Energy Type and Effect for energy review. This 7 items are called as inventory. Detailed explanations are as below.

3.1.1 Activity (or Process)

It is each relevant process name in a manufacturing process for examining energy. If not the manufacturing workplace, it is relevant to an activity name rather than a manufacturing process.

Ex.) Aging Process, Printing Process

3.1.2 Facility

It means a facility belonged to an activity (or a process). There may be one or more relevant facilities for a process.

Ex.) Dryer, Printer, Press

3.1.3 Energy Source

It is a source of energy used for facilities.

Ex.) Electricity, B-C Oil, LNG

3.1.4 Energy Usage

It means facility's energy usage for each unit duration.

Ex.) 50 Mwh/year

3.1.5 Energy Aspect

Record current situation understood for the relevant facility's energy usage by unit duration.

Ex.) Efficiency reduction due to transformer aging, Installing a damper on the fan side to increase the fan's operating power

3.1.6 Type

Understand a type of the grasped energy side to record. that is, classify into a type of high energy consumption or one of low energy efficiency due to the understood current situation.

Ex.) High consumption, Low efficiency

〈Table 3〉 Assessment items and criteria of En-FMEA

Controlling Documents S (1~3)	
1	No requirements, energy policy or law cover the referred energy effect.
5	The energy effect will, in the near future, be regulated either by law, managing documents or an energy policy of the company itself.
9	Regulated by law or managing documents and/or runs against the energy policy of the company.
Public Image I (1~3)	
1	Has no negative influence on the energy reputation of the company.
5	Has no direct negative influence on the energy reputation of the company but might affect the opinion of the public indirectly.
9	Has serious negative effects on the public opinion of the energy reputation of the company.
Use of Energy O (1~3)	
1~3	No negative energy waste lies within the field for which the Energy-team has the competence to judge.
4~6	Energy waste is short-term or temporary.
7~9	Energy waste is long-term or permanent.

3.1.7 Effect

Estimate and understand energy usage lost by the type to record it. In other words, it means energy usage which could be saved through energy improvement.

Ex.) 8 Hwh/year

3.2 Assessment Items and Assessment Criteria

Assessment items are divided into document control, public images and energy usage, and refer to Lindahl's SIO assessment method. It could be considered that document control (S) is relevant to legal regulations, and social images (I) and energy usage (O) correspond to the interested parties and unnecessary energy waste quantity, respectively.

The assessment method gives 1, 2 and 3 points for S, I and O, respectively.

It is defined as EnPN = S + I + O, where EnPN is the abbreviation for 'Energy Priority Number'. The minimum and maximum values of EnPN are 3 and 27 points, respectively. The assessment criteria are referred to Lindahl's one, and the prepared one is as <Table 3>.

〈Table 4〉 Assessment criteria of Improvement Possibility F

Improvement Possibility F (1~9)	
1	No improvement possibility.
2~3	Small improvement possibility.
4~6	Some improvement possibility.
7~8	Large improvement possibility.
9	Very large improvement possibility.

When the assessment for S, I and O is completed, it would evaluate F index which is Improvement Possibility. The assessment criteria for F is as the <Table 4> below, and is referred to Lindahl's assessment method. The range of assessment score is between 1 to 9.

3.3 Assessment Matrix

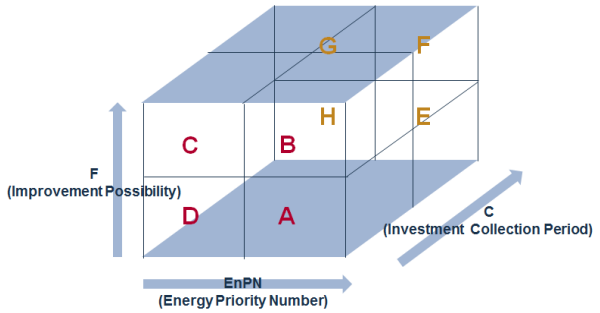
When the assessment for F is completed, it would evaluate C index. C index is defined Investment Collection Period. Costs could be incurred for facility investment or improvement to do activities for energy saving or energy efficiency enhancement, and it should calculate the anticipated investment costs and the estimated reduction amount through energy improvement and understand when the break-even point is. As the investment recovery period is shorter, it could be profitable to companies. There is no separate assessment criteria table for C index, and it could be said that the time corresponding to the break-even point is an assessment criteria.

When the assessment for EnPN, F and C is also completed, a proposal for improvement is conducted, and an Assessment Matrix is prepared for it.

The Assessment Matrix is prepared to understand a total of three kinds such as EnPN, F and C indexes. EnPN, F scores and Investment Collection Period are marked as points on X, Y and Z axes of the Assessment Matrix, respectively. Through the Assessment Matrix, analysis could be carried out easily on the result, items are found and prioritized for energy improvement, and it is a tool suitable for preparing measures. <Figure 4> is Assessment Matrix of En-FMEA.

The Assessment Matrix is divided into a total of 8 sectors

from A to H. If a point is marked on the Assessment Matrix, it is plotted in one of 8 sectors, and considerations for each sector are as below.



〈Figure 4〉 Assessment Matrix of En-FMEA

A (EnPN : high, F : low, C : short-term) : Energy improvement is needed because EnPN is high, but introduction of new facilities or technologies is usually examined to enhance energy saving or efficiency, so investment costs are incurred.

B (EnPN : high, F : high, C : short-term) : Energy improvement is needed because EnPN is high, and it could be relatively easy to improve energy because the F value is high. It could be improved at lower cost by adjusting the setting values of the existing facilities or by operational improvement without introducing new facilities or technologies.

C (EnPN : low, F : high, C : short-term) : There is little need for improvement because EnPN is low, but it could be relatively easy to improve energy because F is high, so there is a need to examine improvement.

D (EnPN : low, F : low, C : short-term) : There is little need for improvement because EnPN is low, and it is expected to introduce new facilities or technologies for improving because F is also low, so it is more desirable to keep the present state rather than improvement.

E (EnPN : high, F : low, C : long-term) : It is the same as the A sector. But the Investment Collection Period corresponds to a long-term.

F (EnPN : high, F : high, C : long-term) : Energy improvement is needed because EnPN is high, and the F value is high, but somewhat investment is required for energy improvement. Even though there is no need to introduce new facilities or technologies, energy could be improved by exploiting the existing facilities and carrying out repair or replacement of parts. costs invested for energy improvement are likely to be high.

G (EnPN : low, F : high, C : long-term) : There is little need for energy improvement because EnPN is low, and it could be easy to improve because F is high, but its investment costs are likely to be high. It may be desirable to keep the present state.

H (EnPN : low, F : low, C : long-term) : There is little need for energy improvement because EnPN is low, it is not easy to improve because F is also low, and its investment costs are high even if improvement is carried out, so it is desirable to keep the present state.

Even though it could not be said that the above considerations for each sector are unconditional, it is considered to be helpful in making a decision. After marking points on the Assessment Matrix, if it is understood in which sector is included to refer to the considerations for each sector, more accurate decisions could be prepared for energy improvement. <Figure 5> is form of En-FMEA.

Energy - FMEA

Project		Date	
Model		Manger	
Process		Sub Manager	

Review Item								Assessment						Action								Review		
No.	Activity (Process)	Facility	Energy Source	Energy Usage	Energy Aspect	Type	Effect	S	I	O	EnPN	F	C	Countermeasure	Effect	I	S	O	EnPN	F	C	Comments	Date	The person in Charge

〈Figure 5〉 Form of En-FMEA

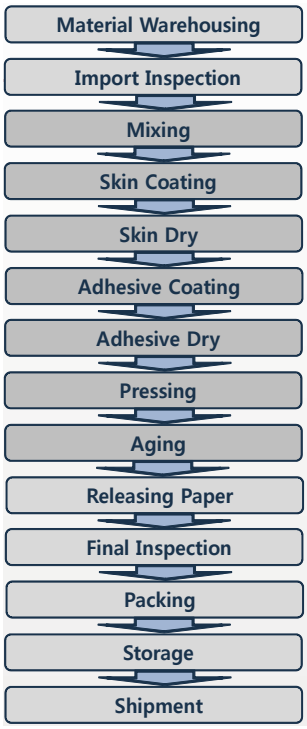
4. Case Study

This study was intended for a D company's dry process which produces synthetic leather for mobile smart phone cases. The D company had constructed a dry synthetic leather production line domestically for the first time in 1966, and is one of the best companies in the industry for technical capabilities and product development level etc.

To apply the developed En-FMEA, a case study was carried out for each stage.

Stage 1 : First, select an object. In this case, a dry process is selected. Synthetic leather production is divided into dry and wet processes, in which the dry process is the most fundamental process, and it recently tends to develop and manufacture products through a dry process for the purpose of improving workers' safety and health and reducing finished products' VOC (Volatile Organic Compound) due to the eco-friendly trend rather than a wet process which uses a lot of organic solvent. If the process conditions are changed depending on the products manufactured from the relevant line even in the dry process, the changes should also be considered at the same time.

Stage 2 : Draw up a production process chart for the selected object. D company's dry process is as the following <Figure 6>.



〈Figure 6〉 Dry type production process for synthetic leather

Stage 3 : Prepare the review items of En-FMEA based on the Production process chart drawn. The review items are divided into activities (or processes), facilities, energy sources, usages, energy aspects, types and effects. Here, effects mean potential reduction amounts. There are different units of energy usage such as ton, kw and cal etc., but this study standardized them as toe. In the <Figure 7> below, the review items are entered by the production process chart understood in the En-FMEA.

Stage 4 : Carry out an assessment for the prepared review items. First, understand and add up S, I and O values to draw EnPN values, and also understand F and C values. The S, I and O values are divided into from 1 to 9 points. A result of carrying out up to the review items is as the <Figure 8>.

Stage 5 : Draw up the Assessment Matrix. Prioritization should consider EnPN and F values to understand, and then also consider C values together. When understanding priorities by the EnPN and F values, both EnPN and F values are high, so even though the priority is high for energy improvement, it is because it is true that is burden to companies if the Investment Collection Period is long. <Figure 9> is Assessment Matrix of En-FMEA.

Looking into activities (or processes) related to the area A in the Assessment Matrix, it corresponds to material warehousing, import inspection, packing and storage, there are no activities (or processes) related to the area B, and the activities (or processes) related to the area C are skin dry, adhesive dry, pressing, aging, releasing paper and storage. Activities (or processes) related to the area D are material warehousing, import inspection, mixing, skin dry process and storage. These contents are summarized for easier viewing as the <Table 5> below.

Stage 6 : Understand priorities for energy improvement through the prepared Assessment Matrix.

Looking into the above <Table 5>, there are processes overlapped for each area. It is because multiple energy aspects for energy improvement could be drawn even in a process, and the assessment result is different for each energy aspect.

Examining the material warehousing activity related to the area A, its EnPN and F values are 16 and 4 points, respectively. Its Investment Collection Period C is estimated to be about 5 months, and is expected to be relatively short, so it could be considered that its priority for energy improvement is high.

For the skin drying process of various ones related to the area C, it is understood that the increase of energy usage due to slow working speed is a cause of energy consumption, and for this case, EnPN and F values are 10 and 8 points, respectively.

Because it should ultimately be moved to the area D, it becomes a object for energy improvement, and it is understood that could intactly use the existing facilities to improve energy by changing the setting values of working conditions without the need to invest expenses, so it could also be said that has a high priority for energy improvement.

Looking into one of activities related to the area D, it is the storage activity in terms of the lightings in the storage room, and EnPN and F values are 14 and 3 points, respectively. Even though it is ultimately in the area D, it is desirable to be marked on the bottom left of the area D, so it could be intended for an object to be improved, but it could be considered that the priority for improvement is low because its Investment Collection Period is 120 months.

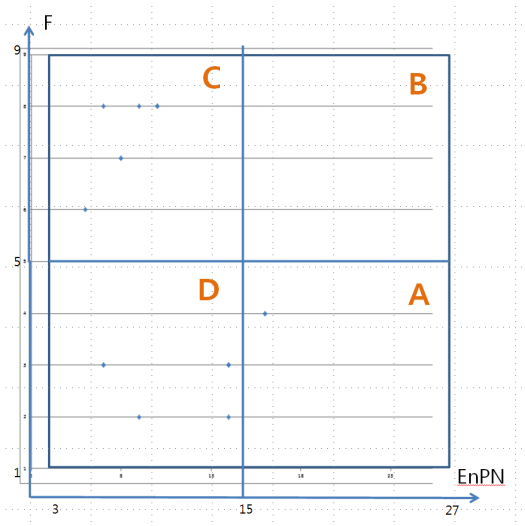
Stage 7: After preparing a plan for improvement by the understood priority and putting it into action, reevaluate EnPN, F and C values.

Review Item							
No.	Activity (Process)	Facility	Energy Souce	Energy Usage	Energy Aspect	Type	Effect
1	Material Warehousing	Forklift	Diesel	0.8 toe	Unnecessarily forklift use	High consumption	0.2 toe
2	Material Warehousing	Warehouse	Electricity	0.03 toe	Lighting of warehouse	High consumption	0.01 toe
3	Import Inspection	Lab.	Electricity	1.5 toe	Lighting of Lab.	High consumption	0.44 toe
4	Mixing	Mixer	Electricity	7 toe	Degradation because of motor deterioration	Low efficiency	2.5 toe
5	Mixing	Mixer	Electricity	7 toe	Little mixing because of characteristic of product	Low efficiency	1 toe
6	Skin Coating & Dry	Chamber	Electricity LNG	300 toe	Energy usage increase because of slow process speed	High consumption	100 toe
7	Skin Coating & Dry	Chamber	Electricity LNG	25 toe	Unnecessarily high temperature	High consumption	20 toe
8	Skin Coating & Dry	Compressor	Electricity	10 toe	Degradation because of compressor Deterioration	Low efficiency	2 toe
9	Adhesive Coating & Dry	Chamber	Electricity LNG	300 toe	Unnecessarily slow process speed	High consumption	100 toe
10	Pressing	Press	Electricity	25 toe	Unnecessarily high temperature	High consumption	5 toe
11	Pressing	Press	Electricity	toe	Unnecessarily high pressure	High consumption	2 toe
12	Aging	Aging room	Electricity	50 toe	Unnecessarily high temperature	High consumption	10 toe
13	Releasing Paper	R/P Machine	Electricity	7 toe	Unnecessarily slow RPM	Low efficiency	2 toe
14	Final Inspection	lab.	Electricity	1.5 toe	Lighting of Lab.	High consumption	0.44 toe
15	Packing	lab.	Electricity	1 toe	Lighting of packing room	High consumption	0.30 toe
16	Storage	Warehouse	Electricity	1.5 toe	Unnecessarily freight elevator use	High consumption	0.2 toe
17	Storage	Warehouse	Electricity	0.03 toe	Lighting of warehouse	High consumption	0.01 toe
18	Shipment	Forklift	Diesel	0.8 toe	Unnecessarily forklift use	High consumption	0.2 toe

〈Figure 7〉 Written review item of En-FMEA

Review Item								Assessment					
No.	Activity (Process)	Facility	Energy Souce	Energy Usage	Energy Aspect	Type	Effect	S	I	O	EnPN	F	C
1	Material Warehousing	Forklift	Diesel	0.8 toe	Unnecessarily forklift use	High consumption	0.2 toe	5	5	6	16	4	5 months
2	Material Warehousing	Warehouse	Electricity	0.03 toe	Lighting of warehouse	High consumption	0.01 toe	5	1	8	14	3	120 months
3	Import Inspection	Lab.	Electricity	1.5 toe	Lighting of Lab.	High consumption	0.44 toe	5	1	8	14	2	60 months
4	Mixing	Mixer	Electricity	7 toe	Degradation because of motor deterioration	Low efficiency	2.5 toe	1	1	7	9	2	18 months
5	Mixing	Mixer	Electricity	7 toe	Little mixing because of characteristic of product	Low efficiency	1 toe	1	1	5	7	3	36 months
6	Skin Coating & Dry	Chamber	Electricity LNG	300 toe	Energy usage increase because of slow process speed	High consumption	100 toe	1	1	8	10	8	0 months
7	Skin Coating & Dry	Chamber	Electricity LNG	25 toe	Unnecessarily high temperature	High consumption	20 toe	1	1	8	10	8	0 months
8	Skin Coating & Dry	Compressor	Electricity	10 toe	Degradation because of compressor Deterioration	Low efficiency	2 toe	1	1	5	7	3	18 months
9	Adhesive Coating & Dry	Chamber	Electricity LNG	300 toe	Unnecessarily slow process speed	High consumption	100 toe	1	1	8	10	8	0 months
10	Pressing	Press	Electricity	25 toe	Unnecessarily high temperature	High consumption	5 toe	1	1	6	8	7	0 months
11	Pressing	Press	Electricity	toe	Unnecessarily high pressure	High consumption	2 toe	1	1	6	8	7	0 months
12	Aging	Aging room	Electricity	50 toe	Unnecessarily high temperature	High consumption	10 toe	1	1	7	9	8	0 months
13	Releasing Paper	R/P Machine	Electricity	7 toe	Unnecessarily slow RPM	Low efficiency	2 toe	1	1	5	7	8	0 months
14	Final Inspection	lab.	Electricity	1.5 toe	Lighting of Lab.	High consumption	0.44 toe	5	1	8	14	3	60 months
15	Packing	lab.	Electricity	1 toe	Lighting of packing room	High consumption	0.30 toe	5	1	8	14	3	84 months
16	Storage	Warehouse	Electricity	1.5 toe	Unnecessarily freight elevator use	High consumption	0.2 toe	1	1	4	6	6	0 months
17	Storage	Warehouse	Electricity	0.03 toe	Lighting of warehouse	High consumption	0.01 toe	5	1	8	14	3	120 months
18	Shipment	Forklift	Diesel	0.8 toe	Unnecessarily forklift use	High consumption	0.2 toe	5	5	6	16	4	5 months

〈Figure 8〉 Written assessment results of En-FMEA



〈Figure 9〉 Drawn Assessment Matrix of En-FMEA

〈Table 5〉 Areal process

Area	Process
A	Material Warehousing, Import Inspection, Packing, Storage
B	N/A
C	Skin Dry, Adhsive Dry, Pressing, Aging, Releasing Paper, Sotrage
D	Material Warehousing, Import Inspection, Mixing, Skin Dry, Storage

5. Conclusions and Outlook

This paper developed Energy-FMEA (En-FMEA) and defined

a procedure for En-FMEA which is a design method considering energy aspects, and proposed a method for efficient En-FMEA. It divided the inventory of En-FMEA into seven items, and proposed a classification method.

Above all things, Experts of each activity (or process) attend a meeting for brainstorming to apply En-FMEA. It is important to grasp energy consumption for each activity (or process).

En-FMEA is a method being carried out at the initial stage for ISO 50001 Energy Review, which can quickly improve energy consumption and energy efficiency. If the proposed method is applied, a proper improvement plan could be proposed by classifying items in detail.

This study established seven items as the inventory items for implementing En-FMEA used in the considering energy aspects and showed a result of implementing through a case study. Further studies need to verify the validity of the assessment method carried out by classifying the inventory items, and should apply the following method to various industries stage by stage to verify energy assessment.

If the methodology suggested in this paper is applied to many companies, it could be considered to bring many advances in the industry considering energy improvement in compliance with global energy improvement activities.

In addition, it is considered to be of practical help to constructing the ISO 50001 Energy Management System.

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