One Stop Solution from Understanding Facts, Setting Goals, to Optimization AI Support for Plant Operation

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This report describes a project case example in which the ENERGY CLOUD™ Service, MHI's comprehensive energy solution service using its own AI&IoT technologies, was applied for the improvement of operational efficiency at a Waste to Energy plant. As an approach to solving problems, the optimization was performed through an understanding of the current state from the aspects of both the operator and plant and based on the setting of goals with experts from various fields being involved. As a result, the calorific value of the waste to be incinerated in the future was predicted with an accuracy of 95% or greater, and the operational guidance into which the expertise of experienced operators was incorporated was presented, thereby realizing support for operational decision-making that is quicker and independent of individual skill.

1. Introduction

In recent years, the environment surrounding plant O&M (Operations and Maintenance) has been changing as listed below and solutions that differ from those of existing approaches are in demand.

(1) Increase in market needs for more inexpensive and higher quality services and the prolongation of plant service life

(2) Manifestation of the problem in transferring operator skills due to work force reduction and an increase in operational complexity

(3) High-speed and inexpensive implementation of information processing and communications realized by the progress of ICT technology

Figure 1 Overview of Jukan Operation Co., Ltd. (JKO)

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JUKAN OPERATION CO., LTD. (JKO), which is an MHI Group company dealing with plant O&M, possesses safe and stable operation and preventive maintenance technologies and promotes operations that increase the values of facilities. An overview of JKO is shown in **Figure 1**.

To address the changing environment surrounding plant O&M and provide higher-quality services to customers, JKO has been seeking solutions that improve operational efficiency. Under the circumstances, MHI applied the ENERGY CLOUD^{TM} Service, which is a comprehensive energy solution service using its own AI&IoT technologies, to the Waste to Energy plant that JKO operates and manages and realized the improvement of operational efficiency in the field.

This report introduces the content of the project implemented toward solving a series of problems and the results are described as a case example.

2. Content of the project implemented toward solving problems

In a problem solving project that is a way of obtaining insight from data using AI (Artificial Intelligence) and IoT (Internet of Things), it is important to properly understand the current state and then sharply narrow down goals. Being devoted to only collecting data with abstract goals being set or the introduction of a system as a makeshift solution will cause economic and temporal losses, resulting in the deterioration of customer value.

MHI/JKO, which have ENERGY CLOUD^{TM}, our own AI&IoT technologies, and MHPS Control Systems Co., Ltd. (MHPS-CS), which features strength in system solutions, tried to solve problems through the following approach:

(1) Understanding of current state: Understanding of the current onsite state from the aspect of both the operator and plant and narrowing down of targets

(2) Setting of goals: Co-creation and consensus formation through discussions among persons concerned from various perspectives

(3) Optimization: Prediction of future using ENERGY CLOUD^{TM} and provision of guidance based on the prediction

An outline of the content of the approach is given in **Figure 2** and the details will be described later.

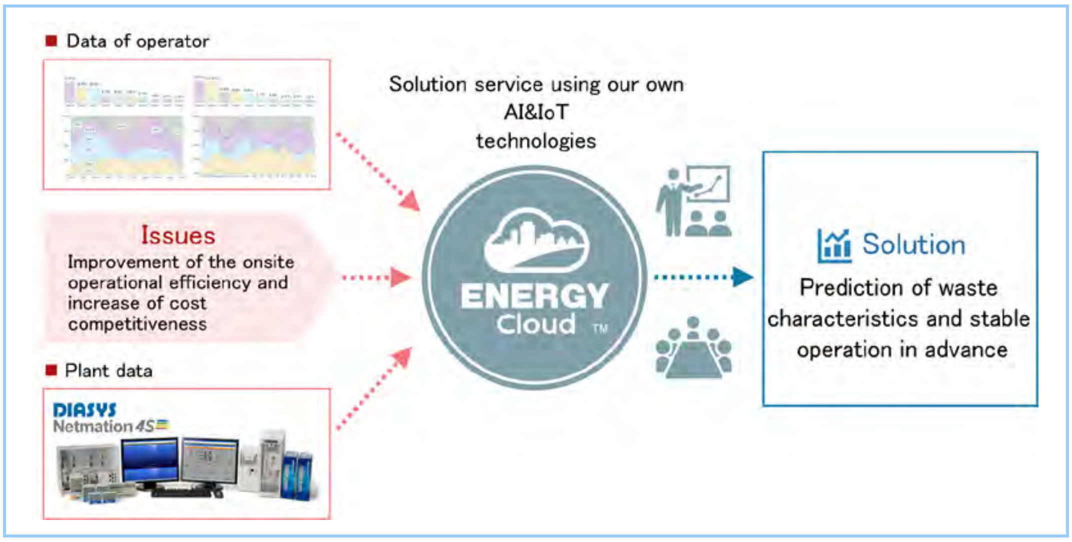

Figure 2 Outline of the approach

2.1 Understanding of current state

For the purpose of objectively understanding the actual state and then narrowing down the system implementation targets, first a questionnaire survey was conducted to multiple plants which conduct Waste to Energy plant operations. Operational loads visualized by kind of operation and time zone based on the survey results are presented in **Figure 3**. In some tasks, the operational load is high only in a certain time zone. In other tasks, operations are conducted continuously for 24 hours. Thus, it shows that the characteristics differ by the content of the operation. The visualization of processes like this eliminates biases such as "misunderstanding by the person in charge" and allows the narrowing-down of system implementation targets that have a higher investment recovery effect.

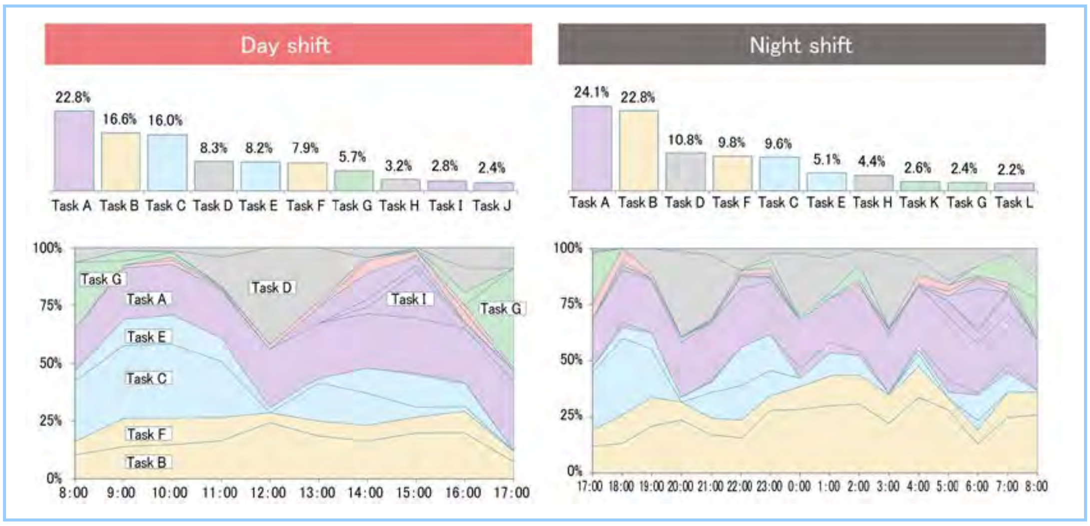

Figure 3 Example of visualized operational loads of operators

It is also important to understand plant operating state and characteristics, as well as human operational loads. Several hundred pieces of time-series operational data per system were extracted from DIASYS Netmation^{TM}, which is a Distributed Control System (DCS) that has already been introduced to the plant, and were subjected to the Exploratory Data Analysis (EDA) for visualization, the exploration of patterns and extraction of correlations. DIASYS Netmation^{TM} has been supplied to more than 2000 projects in the world and has been well received because of its high reliability and precise functions. The appearance of DIASYS Netmation^{TM} and the delivery results are illustrated in **Figure 4**.

These steady efforts to understand the current state are very important in defining a baseline toward the success of the project.

Figure 4 Appearance of DIASYS Netmation^{TM} and delivery results [(1)]

2.2 Setting of goals

Based on the results of the understanding of the current state, discussions were made among the persons concerned from various perspectives. As a result, the assumption was set that the prediction of the "waste calorific value," which is an entry condition from outside the plant, could improve operational efficiency inside the plant.

In this case example, the Key Factors for Success (KFS) in the setting of goals are as follows (**Figure 5**):

(1) Setting of appropriate scope

For the improvement of operational efficiency from a narrow perspective, problems are solved in a single equipment or per unit, and from a broad perspective, problems are solved in an economic unit (ecosystem) including the plant and its upstream and downstream. From which perspective problems should be solved depends on the user's intention and the scope of data. For example, in the case of problem solving in a single equipment, the equipment and peripheral data are needed. On the other hand, in the case of problem solving in an ecosystem, sufficient data from outside the plant are needed, but the importance of the characteristic data of single equipment is relatively lowered.

(2) Involving experts from various fields

In this case example, experts from various fields, such as operating tasks, plant design, data science, system implementation and business, made discussions and set the goals. It is important to incorporate complex perspectives such as onsite feasibility and acceptability.

(3) Agile project implementation as a precondition

Concerning the method of solving problems by using AI (Artificial Intelligence) and obtaining insight from data, there is a high possibility that it will not be economically viable at the present technological level if accuracy close to 100% is required. Rather than adhering to an increase in accuracy, which results in a delay in decision-making, agile project implementation is more important in which a project is conducted quickly on a small scale with an appropriate level of accuracy to accelerate the evaluation cycle.

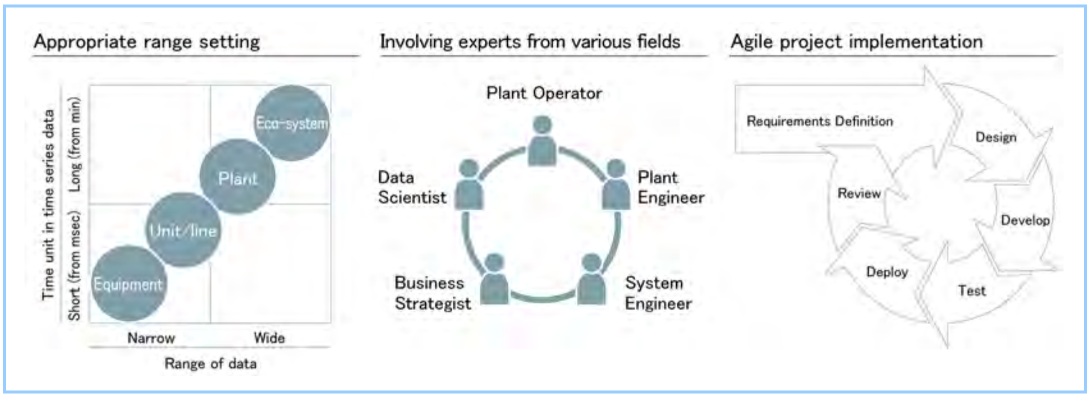

Figure 5 Key Factors for Success (KFS) in the setting of goals

2.3 Optimization

A system in which ENERGY CLOUD™ is used to predict the calorific value of the waste to be incinerated one hour later based on the set goals was established. The prediction results are depicted in **Figure 6**. In the evaluation period of one month, a prediction accuracy of 95% or greater was achieved. It was confirmed that the system can sufficiently support the decision making of operators. The accuracy is defined with the predictive relative error (rate of predictive error relative to true value) being as the difference from 100%.

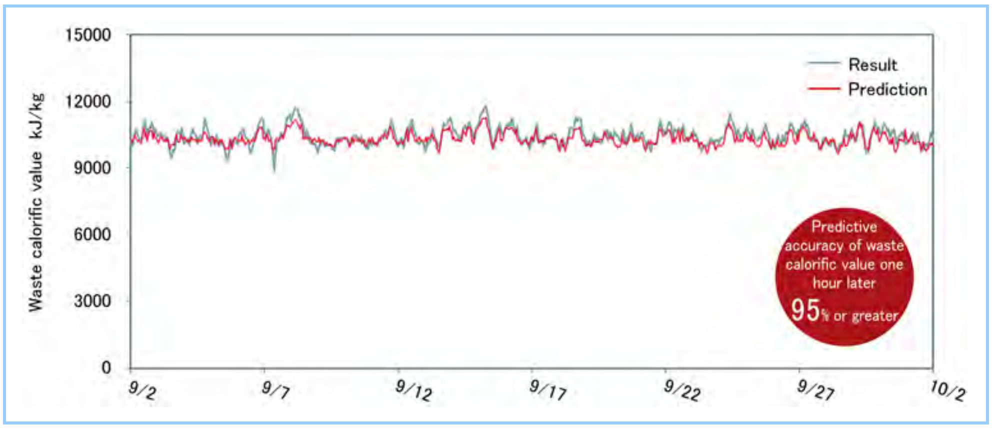

Figure 6 Prediction results for the waste calorific value by ENERGY CLOUD™

In addition, the function of performing operational guidance based on the waste calorific value predicted using ENERGY CLOUD™ and the expertise of experienced operators was constructed using DIASYS Netmation™. An example of the operational guidance screen can be seen in **Figure 7**.

In this function, the operational indices to operational parameters are computed based on the predicted value for the calorific value of the waste to be incinerated in the future, and if any current value deviates from a certain range, it is indicated in red, thereby supporting the decision-making on operation which is quicker and more independent of individual skill compared to the conventional system, allowing the realization of the improvement of operational efficiency. By realizing the improvement of operational efficiency, safe operation and the prolongation of the service life of the plant can also be promoted.

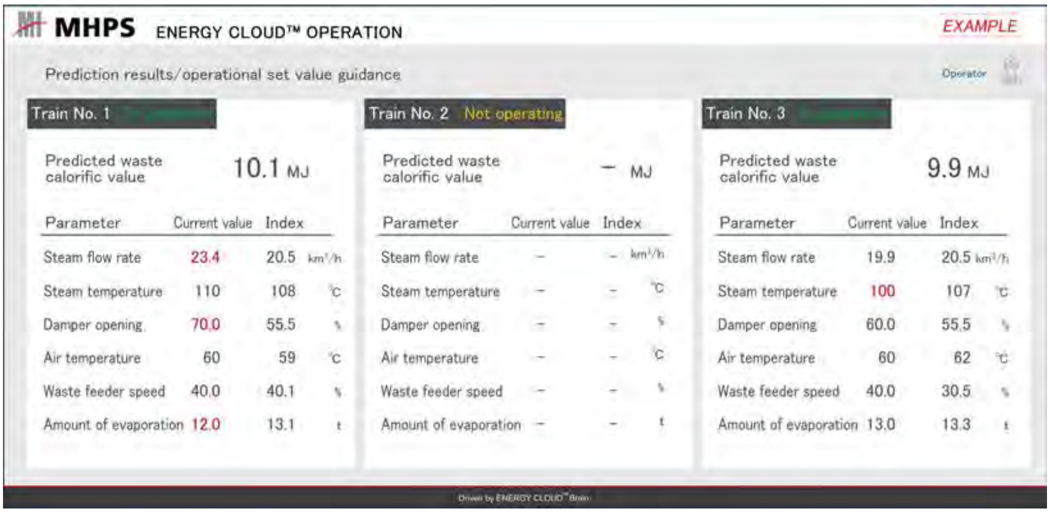

Figure 7 Example of the operational guidance screen

3. Conclusion

This report described the solution by which ENERGY CLOUD™ is used to predict the waste calorific value with an accuracy of 95% or greater and to provide operational guidance for the purpose of improving operational efficiency at a Waste to Energy plant. In the future, we will contribute to the formation of a recycling-oriented society through the expansion of customer contents and the improvement of technologies.

This technology and the approach to the solution can be applied not only to Waste to Energy plants, but also to various fields such as power generation, chemical plants and manufacturing equipment. We will make efforts to solve various issues mainly focusing on the energy and environmental fields.

References

(1) Control Systems What is DIASYS? https://www.mhps.com/products/control-systems/outline/