Asset Management System for Electrical Distribution & Transmission Lines of Business

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1. Introduction

Due to energy network price controls, electric power companies must provide appropriate explanations for asset investments as energy network costs. However, many assets that were introduced during the period of high economic growth and the bubble economy are aging, which will increase maintenance costs. In addition, experienced engineers are growing older and the labor force is shrinking. Suppressing maintenance costs while increasing the number of workers is mutually contradictory, and so investments for maintaining necessary assets in order to stabilize electric power systems must be properly explained. Therefore, instead of conventional time-based maintenance (TBM) in which aged assets are replaced and refurbished, risk-based maintenance (RBM) is needed. In RBM, the conditions and risks of assets are identified and investments in asset maintenance are planned and made accordingly. This paper describes Mitsubishi Electric Corporation's asset management system and its functions.

2. Work on Asset Management

As international asset management standards, the ISO55000 series were issued in 2014. In these series, all elements from an organization's plans and goals (vision) to its policies, strategies, and plans of actual worksites are regarded as a single flow (hereafter, "Line of Sight") and a framework in which all stakeholders from top management to operators at worksites needs to be established (Fig. 1).

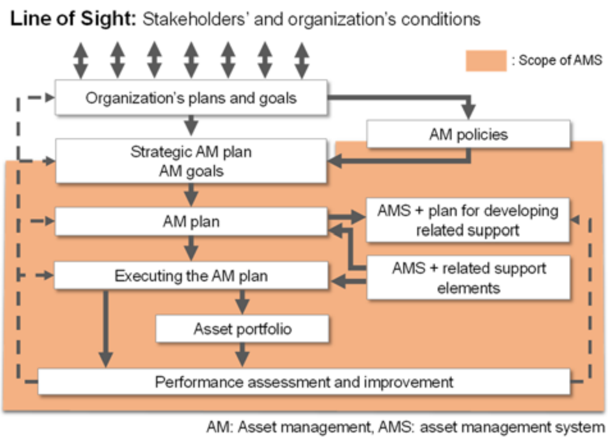

Fig. 1 Relationship among elements of the asset management system (1)

In addition, based on the concept of the ISO55000 series, IEC/TC123 (Management of network assets in power systems), which focuses on asset management of electrical distribution facilities, was established in October 2016 under the leadership of Japan. This group has been considering medium- and long-term strategies, life cycle costs, and standardization of risk analysis and other operations.

Furthermore, the Electric Technology Research Association in Japan started literature research in FY2018 on the theme of "A study on improving the maintenance of substation facilities and asset management."

In line with this trend, Mitsubishi Electric strives to assess and quantify risk based on asset conditions, and to apply developed plans to actual worksites.

3. Overview of Mitsubishi Electric's Asset Management System

As described above, in view of the need for asset management in Japan and overseas, Mitsubishi Electric offers an asset management system for the electrical distribution and transmission lines of business. Table 1 lists the requirements, Table 2 lists the functions to be provided, and Fig. 2 shows the functional composition that was determined based on recent trends and problems in the electrical distribution and transmission lines of business.

3.1 EAM

For customers who have various types of assets, Mitsubishi Electric has been offering products with functions that can be commonly used in maintenance operations and integrated asset database management platforms.

3.1.1 DiaPassage

Mitsubishi Electric has been providing customers in the societal infrastructure industry with DiaPassage,

Table 1 Asset management requirements

No	Asset management requirements
1	Risk assessment and quantification based on asset conditions
2	Formation of asset replacement and refurbishment plans based on the risk assessments and objective evaluations
3	Application of the plans to actual worksites considering Line of Sight

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Table 2 Functions of MELCO's asset management system

Function		Details
EAM	Asset maintenance and management	Centrally manages the asset lists and records of a company.
	Inspection plan management	Manages inspection plans.
	Support of construction and operations and management of actual results	Assigns workers and equipment according to the plans and manages operations.
APM	Asset condition check	Calculates and estimates the rank of asset deterioration based on inspection data and other data.
	Function for calculating consequence of failures	Calculates the influences of line failures based on line data.
	Risk assessment	Calculates risks using risk matrices using the asset conditions and consequence of failures as input data.
AIPM	Predictive analytics	Calculates the optimal intervention dates for each asset in consideration of economic efficiency and risks.
	Investment planning support	Supports the formation of medium- and long-term investments plans based on the inspection plans.
	Optimization	Evaluates the planned investments. Computes a plan that maximizes the value for the entire group of investments (hereafter, "portfolio").
	Value framework	Helps align your decision making to goals and priorities

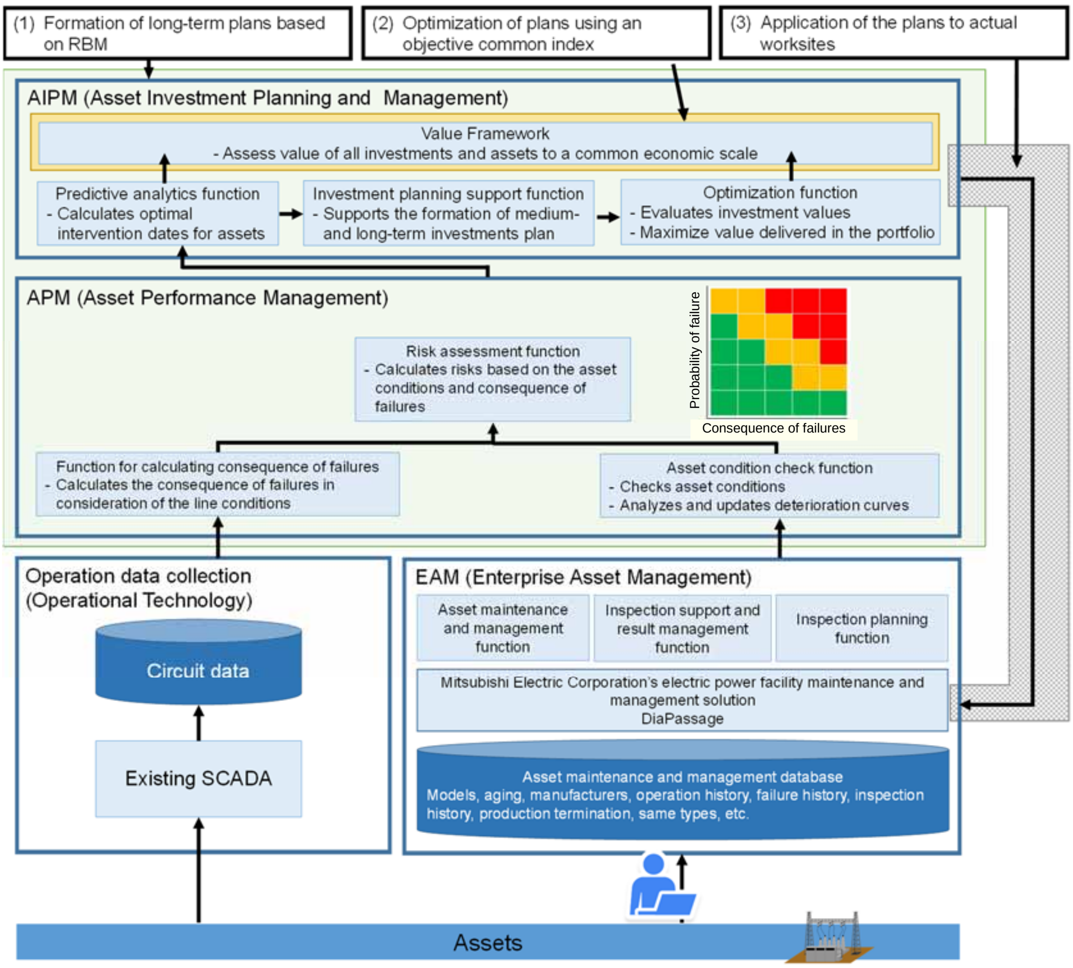

Fig. 2 Overview of MELCO's asset management system

which is an integrated asset database management platform. The asset maintenance and management functions of DiaPassage allow customers to centrally manage asset specifications, drawings, patrol and inspection records, accident history, and information on equipment of the same types as those that caused accidents, thus supporting asset maintenance operations at actual worksites. DiaPassage also manages operations based on maintenance plans.

3.2 APM [2]

Mitsubishi Electric's APM has asset condition check and risk assessment functions and a function for calculating the consequence of failures. APM calculates

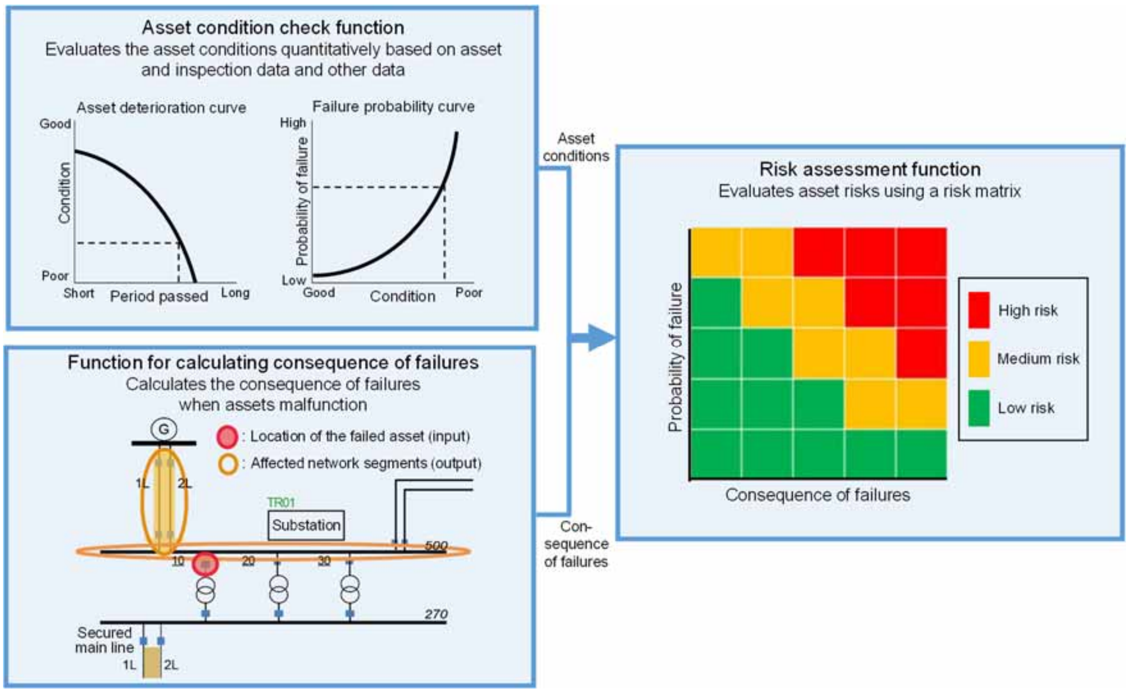

Fig. 3 Structure of MELCO's APM

risks based on the asset conditions and consequence of failures that were calculated by these functions (Fig. 3). In addition, Mitsubishi Electric has been incorporating international standards into APM in system development.

3.2.1 Asset condition check function

The asset condition check function evaluates asset conditions quantitatively based on the asset and inspection data and other data sent from the EAM function. "Asset condition" refers to the degree of deterioration of assets and the probability of failure. The degree of deterioration of an asset is calculated by applying methodologies used in Japan. Mitsubishi Electric has developed a technique to exclude variations caused by differences in individual skills when judging the rank of deterioration of assets based on inspection data, which is the original data for quantification. The relationship between inspection data and deterioration rank is statistically judged and the transition of deterioration ranks is estimated based on the inspection data.

3.2.2 Function for calculating consequence of failures

This function calculates the consequence of failures on assets. Various calculation methods have been proposed. Mitsubishi Electric supports the calculation of the consequence of failures proposed in such methods and has developed its proprietary function for calculating the consequence of failures on circuits. If assets on circuits stop working due to a malfunction or other reason, influences on the surrounding circuits and demand side are quantified in order to judge the consequence of the failure (Fig. 4). This function quantifies the influences of

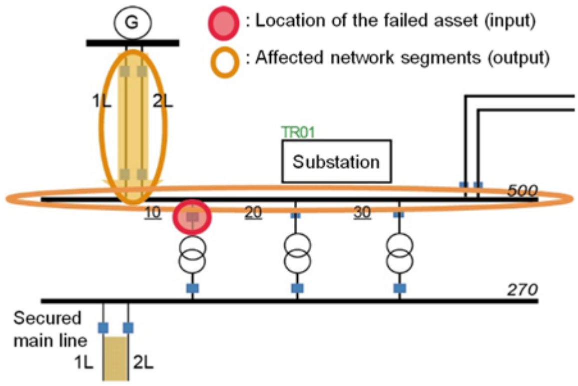

Fig. 4 Consequence of failure calculation

failures on circuits and determines the magnitude of the consequence of a failure for each asset.

3.2.3 Risk assessment function

The risk assessment function assesses risks for each asset based on the asset conditions and consequence of failures calculated by the other functions. A risk matrix is used for risk assessments and the products of the probability of failures and the consequence of failures are used to assess the magnitude of the risks. It can be assumed that assets with high risks need to be handled with priority, while assets with low risks can be handled later. This function is used for assessing risk based on the condition judgment for each asset and the consequence of failures. In addition, when risks are calculated based on various types of consequence of failures, they are converted into a common index (Fig. 5).

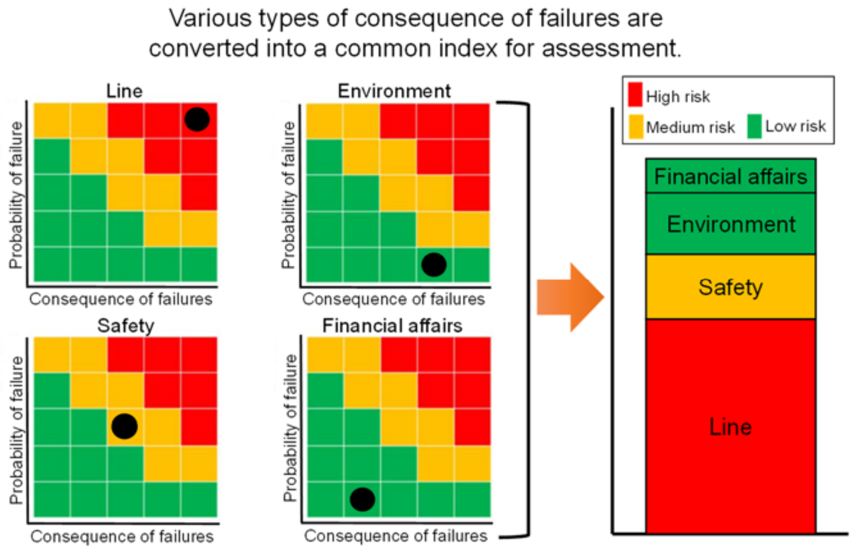

Fig. 5 Concept of risk evaluation

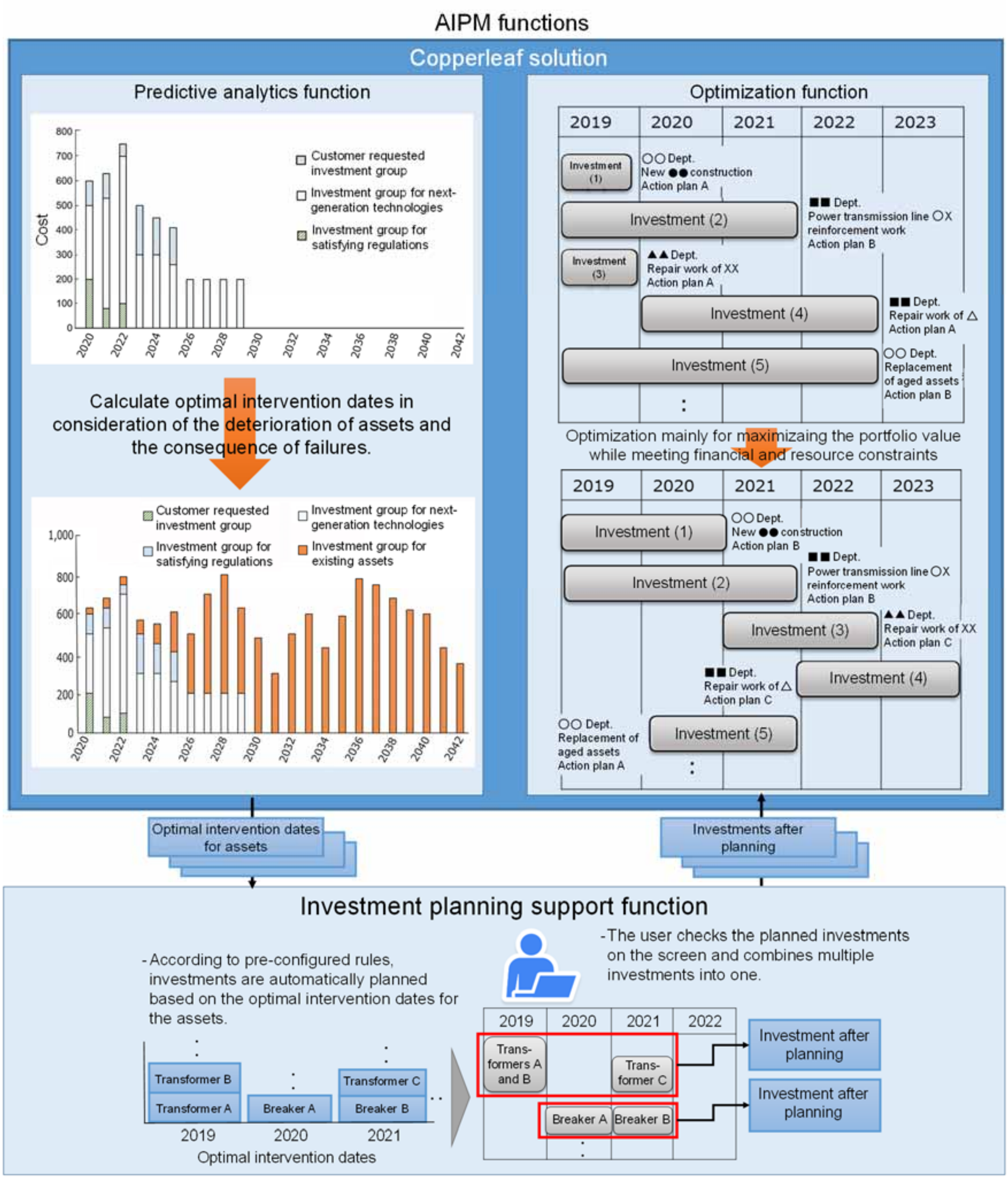

Fig. 6 Structure of MELCO’s AIPM

3.3 AIPM

AIPM consists of predictive analytics, construction planning support, and optimization functions. AIPM plans investments based on the risks of assets and optimizes the investment groups in the portfolio to deliver the greatest value. Mitsubishi Electric has concluded a partnership contract with Copperleaf Technologies Inc., is the leader in the AIPM industry worldwide. The combination of the Copperleaf solution and products of Mitsubishi Electric has resulted in an AIPM tailored to the electrical distribution and transmission lines of business in Japan (Fig. 6).

The Copperleaf solution quantifies various types of value indexes (e.g., the value of avoiding power outage risks and the value of improving operation efficiency) with reference to a common value index (hereafter, "value"), which enables optimization to maximize value and achieve organizational goals. This not only manages risk, but also maximizes financial and non-financial benefits.

3.3.1 Predictive analytics function

The predictive analytics function calculates the optimal intervention date for each asset using the asset conditions and the consequence of the failures that were calculated in section 3.2 as input data. The value calculated by this function based on the risks calculated by the asset condition check function refers to a risk reduction amount. The calculation is repeated to year N in the future to obtain the optimal intervention date that maximizes the value. This function clarifies the asset conditions and risks over the long term (Fig. 7).

3.3.2 Investment planning support function

The investment planning support function assists users in drawing up efficient construction plans based on target asset information obtained by the predictive analytics. For example, in the electrical distribution and transmission lines of business, there is the concept of "bundled work." This means, when there is another asset that will be worked on in the near future near a target asset, working on the two assets at the same time. Construction plans that take into account bundled work can reduce the costs and number of power outages.

3.3.3 Optimization function

The portfolio optimization function computes an investment plan that maximizes the portfolio value. Two possible alternatives can be specified to address a problem with an existing asset (e.g., replacement, refurbishment, and removal) and introduction of a new asset. This function can optimize these two types to maximize the value. For example, regarding an investment for replacing an existing asset, the risk of a power supply problem is reduced by replacing the asset, whereas for an investment for introducing a new asset, the value of the safety and operation efficiency increases. The advantages of such different types of investments are evaluated as values.

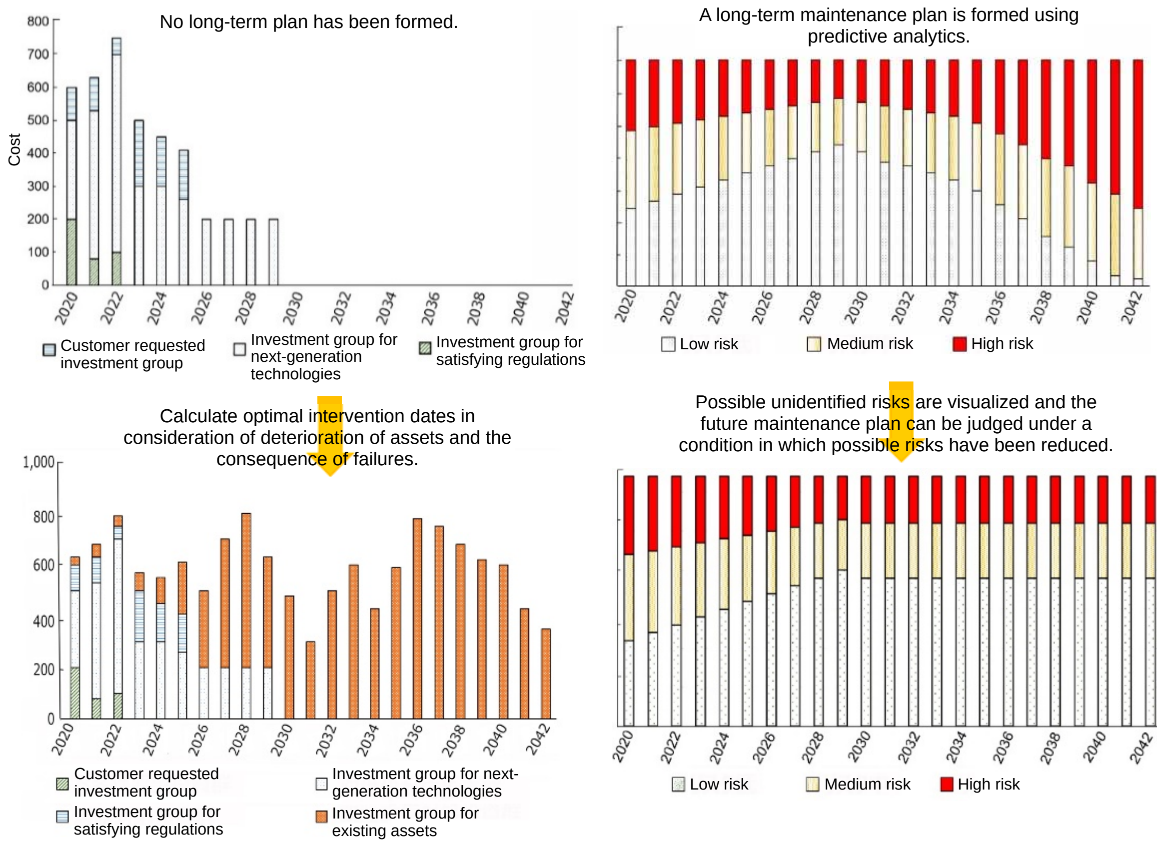

Fig. 7 "Predictive Analytics" using asset risk

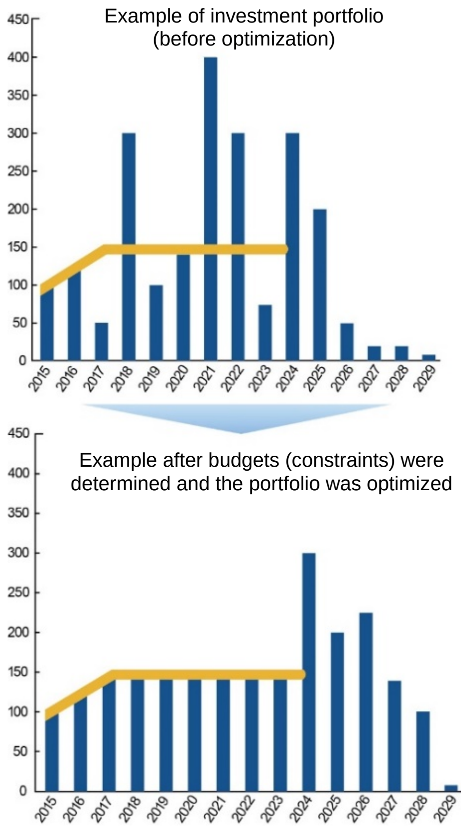

Fig. 8 Example of portfolio optimization

In addition, as shown in Fig. 8, when the investments are added, the investment costs and resources (operators) vary from year to year. Investments plans must meet financial and resource constraints, optimizing the portfolio will yield an investment plan with maximum value while satisfying all constraints.

4. Conclusion

This paper outlined Mitsubishi Electric's asset management system for the electrical distribution and transmission lines of business, and explained how the functions satisfy the asset management requirements.

Mitsubishi Electric will continue to focus on the trend of international standards and contribute to improving the levels and efficiency of asset management for the electrical distribution and transmission lines of business by refining and improving APM and AIPM using asset operation data.

References

(1) H. Kawano.: ISO 55001:2014 Explanations of Asset Management System Requirements, Japanese Standards Association, 41-43 (2015)

(2) IEC White Paper: Strategic asset management of power networks