

Industry & Distribution

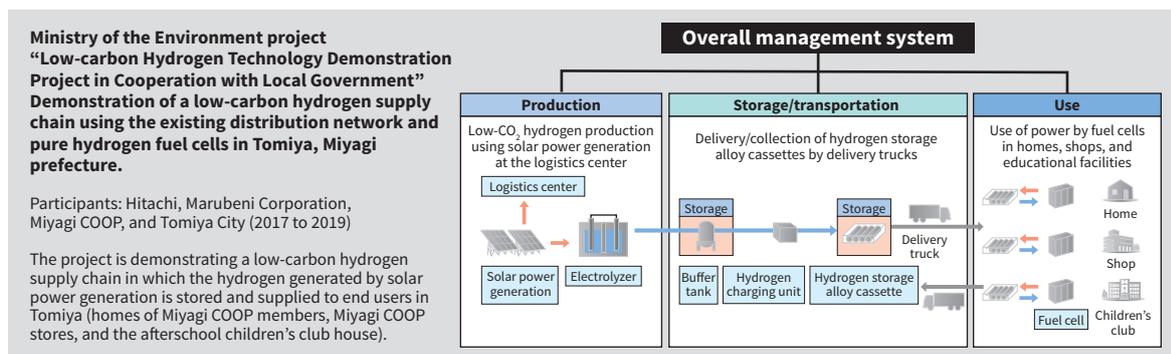
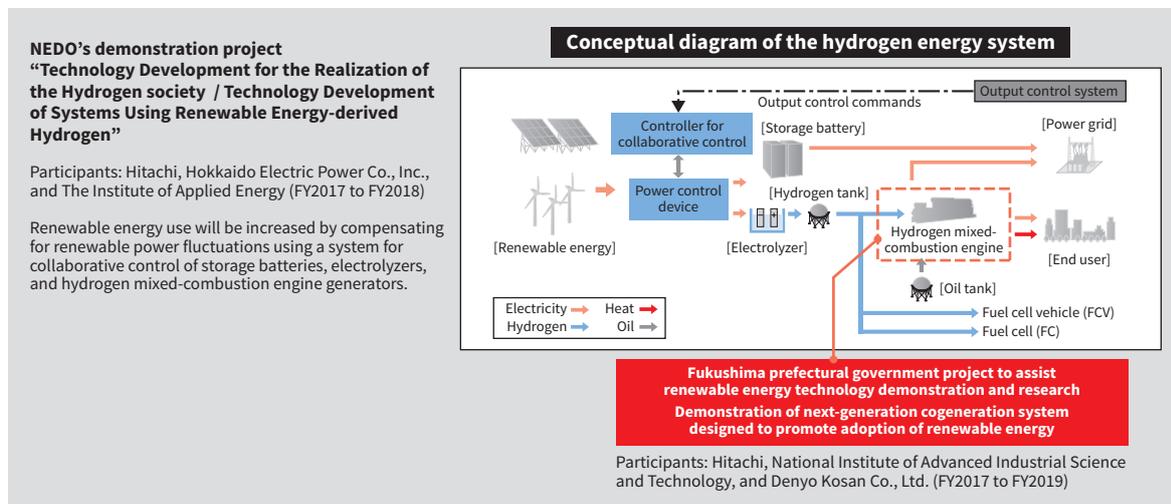
1 Demonstration Project Activities for the Hydrogen Industry

Since it can be used without generating CO₂ emissions, hydrogen is being viewed as a promising energy source for helping reduce the environmental load. Hitachi has responded to the interest in hydrogen by preparing to enter the hydrogen market to be established in 2020 or after. Specifically, the Company is taking part in a national demonstration project in Japan to study hydrogen business models, work on core technology development, and bridge the private and public sectors.

The details of the ongoing demonstration project are as follows:

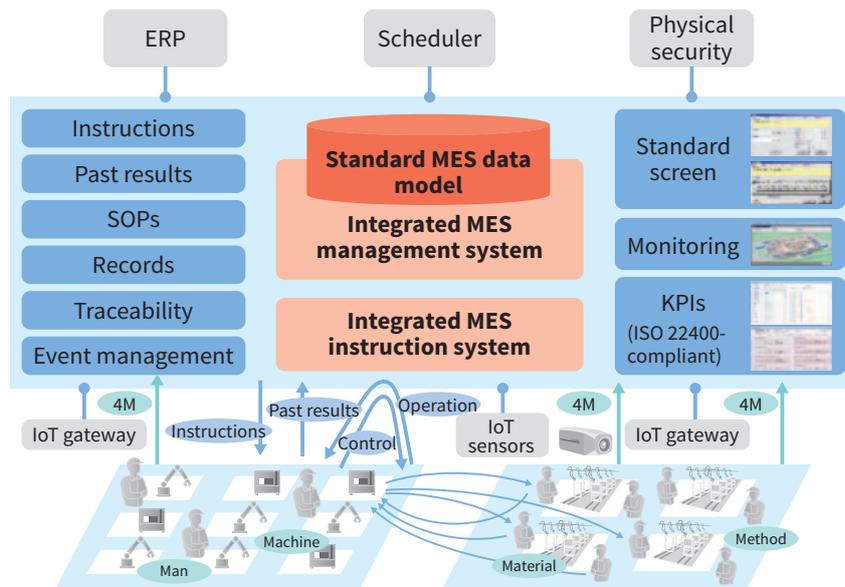
- (1) Creating technology for power fluctuation compensation solutions designed to stabilize power from renewable energy sources in collaboration with power companies and renewable energy providers
- (2) Developing original hydrogen mixed-combustion engine products targeting captive consumption of by-product hydrogen
- (3) Building and demonstrating a hydrogen supply chain created for consumer thermoelectric services and designed to achieve a carbon-free society

These demonstration projects will help lead to a hydrogen energy society while also expanding business activities that can properly exploit the growth of this new hydrogen market.



NEDO: New Energy and Industrial Technology Development Organization

- 1 Development of technology for power fluctuation compensation solutions and hydrogen mixed-combustion engines (top), and creation and demonstration of hydrogen supply chain (bottom)



ERP: enterprise resource planning SOP: standard operation procedure

2 Integrated MES package for creating smart manufacturing sites

2 Integrated MES Package for Machining/Assembly Manufacturers

Manufacturers that handle machining or assembly processes face a variety of challenges. They need to use high-mix low-volume production to enable the production flexibility demanded by increasingly diverse market needs. They must issue optimum work instructions to equipment and personnel in response to constantly changing manufacturing sites. They need to ensure traceability, and handle high-performance and important parts and products with rigorous manufacturing record-keeping and quality control. To help manufacturers meet these challenges, Hitachi has developed an integrated manufacturing execution system (MES) package that uses facts (real-world data) from the manufacturing site to help production proceed with an optimum, waste-free rhythm.

The package is implemented with standard production optimization technologies to help customers achieve systemwide optimization of their manufacturing sites. These technologies include, for example, a visualization function that uses 4M* data from the manufacturing site to make the status and progress of production knowable in real time. There is also an event-driven, non-stop, high-speed function

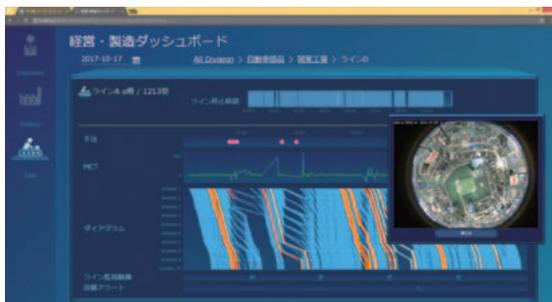
for issuing manufacturing instructions, an ISO 22400-compliant key performance indicator (KPI) monitoring function, and a function for connecting Internet of Things (IoT) solutions.

*4M (from “man,” “machine,” “material” and “method”) is Hitachi’s term for information related to personnel, facilities, materials, and methods.

3 Management/Manufacturing Dashboards Using 4M Data from Manufacturing Sites

Manufacturers seeking to adapt to rapidly changing market environments on a global scale have recently been demanding administrative/production management systems that can rapidly identify and solve management and manufacturing site issues. To meet this demand, Hitachi has developed management and manufacturing dashboards that provide unified platforms for visualizing a wide range of KPIs in areas ranging from management information to manufacturing site statuses.

These systems display time-series graphs of KPIs that can aid the decision-making behind management and productivity improvements. Systems are available for every level of the job hierarchy, ranging from top management to plant managers and line supervisors. They can



3 Example manufacturing dashboard screen (top) and management dashboard screen (bottom)

be used to speed up the cycle of activities, starting with assessing conditions, and extending to identifying issues, evaluating analysis, and making improvements. By integrating 4M data from multiple domestic and overseas plants, the factors that cause defects can be analyzed using big data analysis technology. The improvement measures identified by this analysis can then be fed back to manufacturing sites to help improve product quality worldwide.

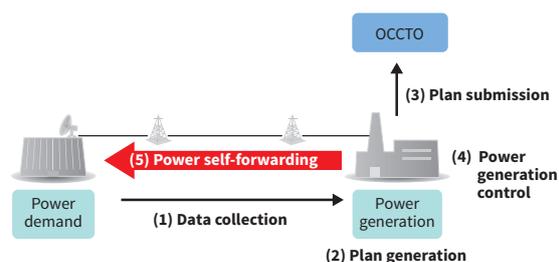
As part of a collaborative creation project being conducted with Daicel Corporation, Hitachi started using manufacturing dashboards for line supervisors in October 2017. The dashboards maximize the use of previously gathered 4M data. The Company will work on refining these systems to enable the use of management dashboards for top management.

4 Power Self-forwarding for Overall Energy Balance Optimization

Manufacturers with multiple plants that consume large amounts of heat and electricity are increasingly looking to using power self-forwarding as a promising way of creating overall energy balance optimization by tracking fluctuations in production items and quantities.

Hitachi has released an energy management system (EMS) that integrates multiple hubs and enables automatic self-forwarding in accordance with a planned value balancing system. Use of the system enables a self-forwarder to automatically operate a cogeneration facility that acquires supply and demand data online, generates forwarding supply plans in 30-minute increments, submits the plans to Japan's Organization for Cross-regional Coordination of Transmission Operators (OCCTO), and matches planned and actual values.

The system has been in use since June 2017 at a bottling plant that has high heat demands. The bottler has installed a large cogeneration facility at the plant and is using EMS to supply excess power to another plant through self-forwarding. This method achieves a major reduction in energy costs and reduces the environmental load.



4 Role of EMS in self-forwarding

5 Facility Trouble and Product Defect Symptom Detection System

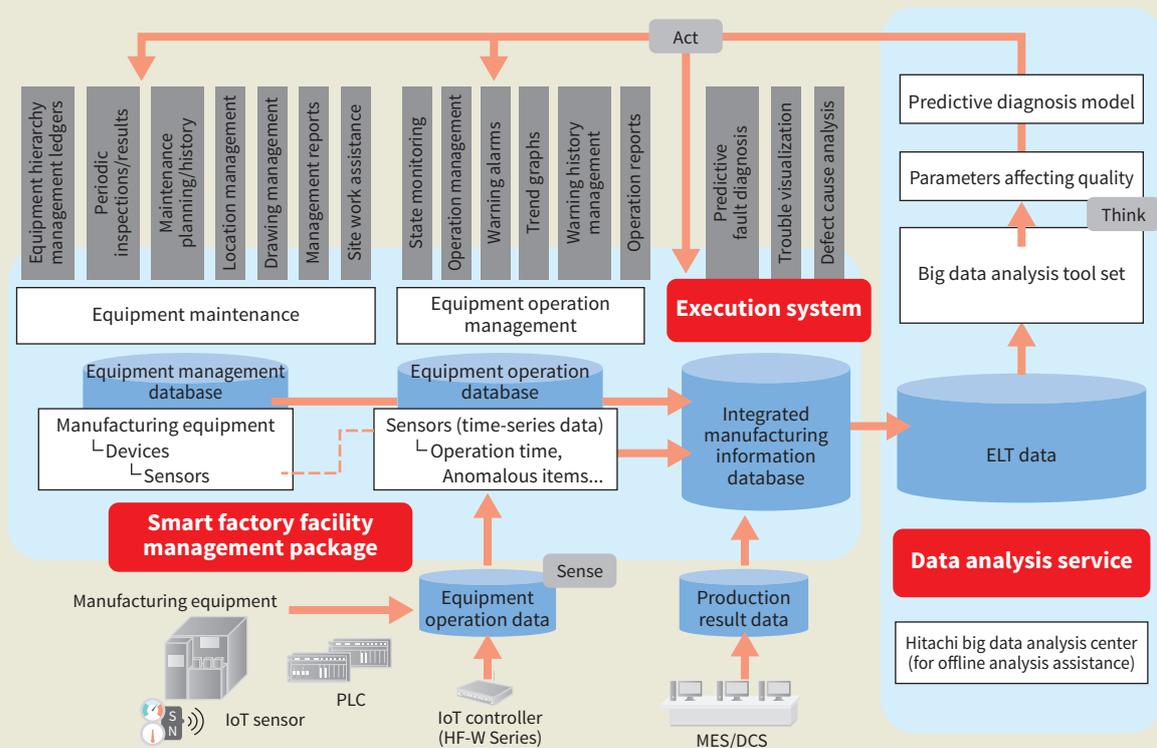
Smart plants have recently been attracting interest. Smart plants are plants that can “think, produce, and manage by themselves” using a cyber-physical system (CPS) that interconnects the manufacturing site with the virtual world. The CPS connects the plant’s devices (including sensors and equipment) to the Internet, to enable visualization of information such as quality and status, to identify causal relationships and enable collaborative work between equipment items (machine to machine, M2M), or between equipment and people. The start of Industrie 4.0 has spurred worldwide moves toward a fourth industrial revolution and created demand for a boost in the generation of new added value using digital solutions. These developments are creating risks for manufacturers such as mega-recalls caused by quality problems. IoT-based early discovery and responses to quality problems that cannot be detected by inspection equipment or the human eye are key issues.

The facility trouble and product defect

symptom detection system provided by Hitachi is a smart plant solution designed to generate new value by using the (physical) manufacturing site as a data generation engine, and “sigma-ing” (summing up) the site data to extract its latent power. The system incorporates the following three points:

- (1) Equipment operation information managed by an equipment management package (Smart factory facility management system)
- (2) Data analysis service for manufacturing equipment data
- (3) Construction of an execution system (predictive equipment diagnosis/quality indicator detection system)

Implementing a facility trouble and product defect symptom detection system enables predictive diagnosis of equipment anomalies and detection of quality problem indicators. Early detection and response to anomalies and defects should enable manufacturers to prevent costs from losses generated from product inspections, disposals, and mega-recalls more effectively than when dealing with defective products and equipment anomalies after-the-fact.



PLC: programmable logic controller DCS: distributed control system ETL: extract, transform, load

5.1 Composition of the facility trouble and product defect symptom detection system solution functions

The three component elements listed above are described below.

(1) Smart factory facility management system

The smart factory facility management system is a web-based system that helps increase maintenance work efficiency through uniform management of information such as maintenance planning and execution fault histories using equipment ledgers. The smart factory facility management system functions in a facility trouble and product defect symptom detection system are equipment maintenance management and equipment data collection and storage. A facility trouble and product defect symptom detection system can detect indicators of quality defects and equipment faults and maximize the information value of manufacturing site data by using an integrated manufacturing information database that combines equipment operation information and production management information (context information) as a base.

(2) Data analysis service

Creating a predictive model is crucial for making predictive online diagnoses. The data analysis service in a facility trouble and product defect symptom detection system investigates indicator detection feasibility and creates a

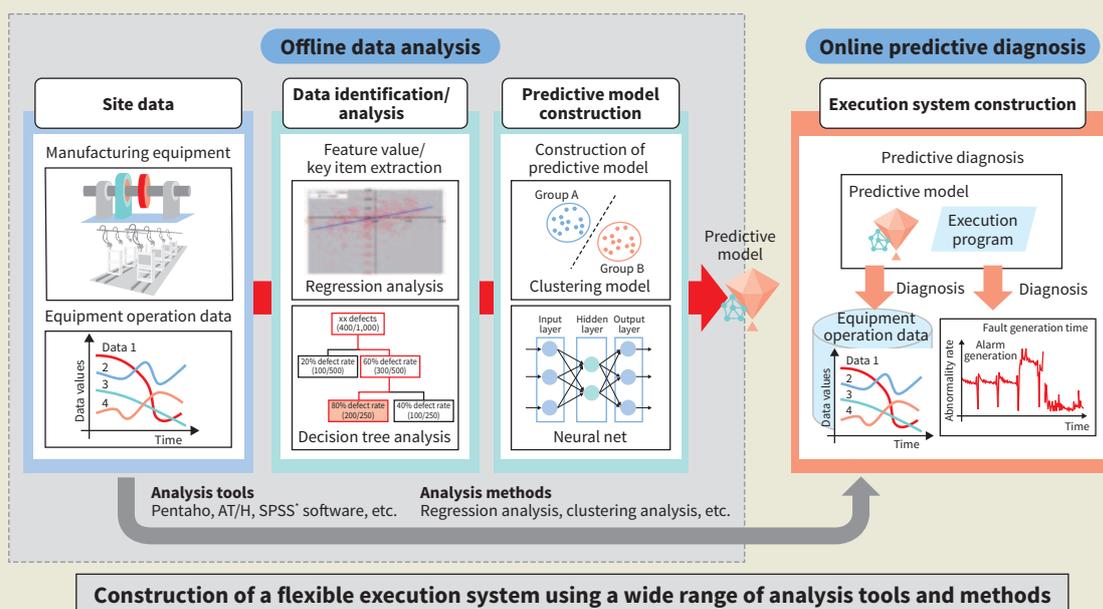
predictive model before the execution system is developed. Data analysis results are reported to the customer, who checks their suitability. If the results are deemed to be unsuitable, Hitachi can propose a new analysis method or request other data to be provided, creating a predictive model through repeated additional analyses.

(3) Predictive equipment diagnosis/quality indicator detection system

The created predictive model is developed as the execution system, and a predictive equipment diagnosis/quality indicator detection system is constructed. This system is used to acquire data stored by smart factory facility management system and process the data needed for indicator detection (data cleansing and feature value extraction). The data is then put into the predictive model. If an indicator of a quality defect or equipment anomaly is detected, an alarm is generated and instructions are issued to staff, reducing costs by preventing anomalies from occurring.

Production hubs are sources of key data for improving productivity. Hitachi will continue to help generate new value by comprehensively analyzing and evaluating IoT data from production hubs.

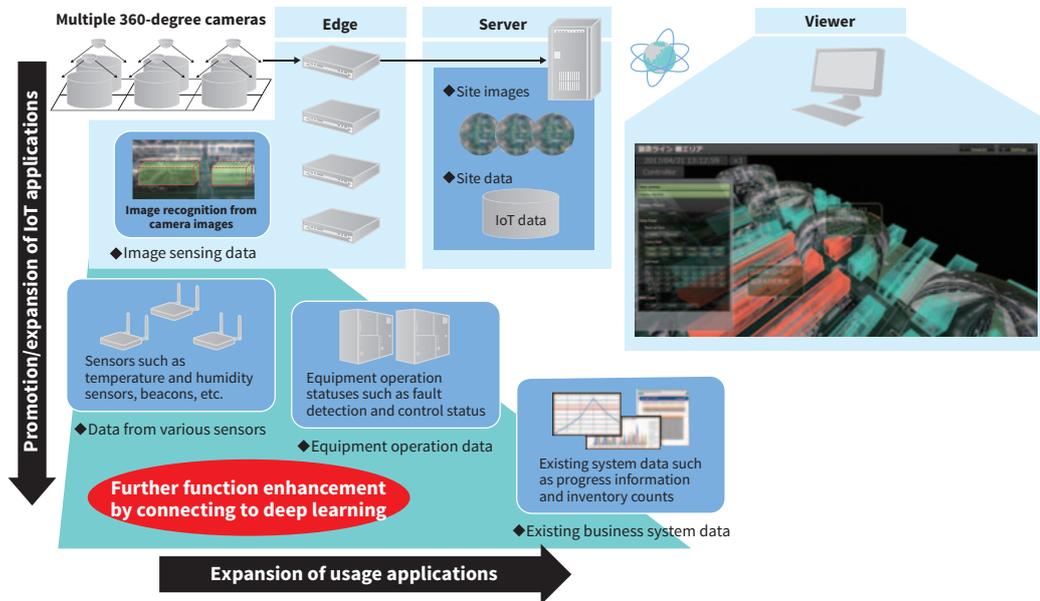
(Hitachi Industry & Control Solutions, Ltd.)



AT/H: Hitachi AI Technology/H SPSS: Statistical Package for the Social Sciences

* See "Trademarks" on page 148.

5.2 Creating predictive model using data analysis, and its relationship to the execution system



6 Overview of multi-view added service for IoT platform

6 Status Collecting and Visualization System Driven by Overhead Images and Image Sensing

Hitachi has developed a status collecting and visualization system called multi-view added service for IoT platform. Conceived as a visualization-driven IoT application, the system uses information acquired from 360-degree camera images to identify site events and the reasons behind them.

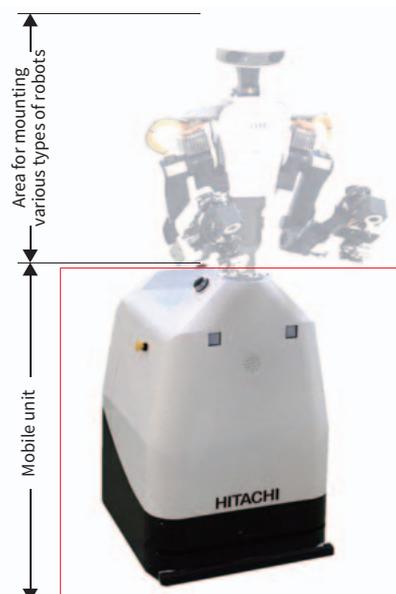
Anomalous values detected at the site are displayed on top of overhead images that multi-view added service for IoT platform gathers and composites every few seconds from multiple 360-degree cameras. The displays let the user immediately recognize objects, people, or locations showing anomalous values. The conditions existing at the time an anomalous value was generated can be also viewed in images taken from several different angles. Multi-view added service for IoT platform is in use at Hitachi's cell production site, where it has improved productivity and machine availability.

Hitachi will connect multi-view added service for IoT platform with open-device, deep-learning, and other platforms, using the system for visualizing customers' challenges from several different angles, contributing to industrial growth by improving the work done at manufacturing and distribution sites.
(Hitachi Industry & Control Solutions, Ltd.)

7 Autonomous Mobile Robot

Recent labor shortages are creating a lot of demand for automation at manufacturing sites in Japan, but several obstacles have made automation difficult. For example, automation methods using conventional robots nearly always use robots that are fixed in place, requiring renovation of existing facilities or separate material handling equipment.

Hitachi has responded by developing an autonomous mobile robot that acts as legs for



7 Autonomous mobile robot with a dual-arm robot manufactured by Kawada Robotics Corporation.

robots allowing them to move around a site. The autonomous mobile robot incorporates autonomous driving technology developed by the Hitachi Research & Development Group, and can move without guidance. Various different robots can be mounted on top of the autonomous mobile robot to enable robot-based automation while minimizing plant/facility renovations. Enabling robots to move around and work in multiple locations makes it possible to maximize robot availability even for intermittent work that has been difficult to automate until now.

(Hitachi Plant Mechanics Co., Ltd.)

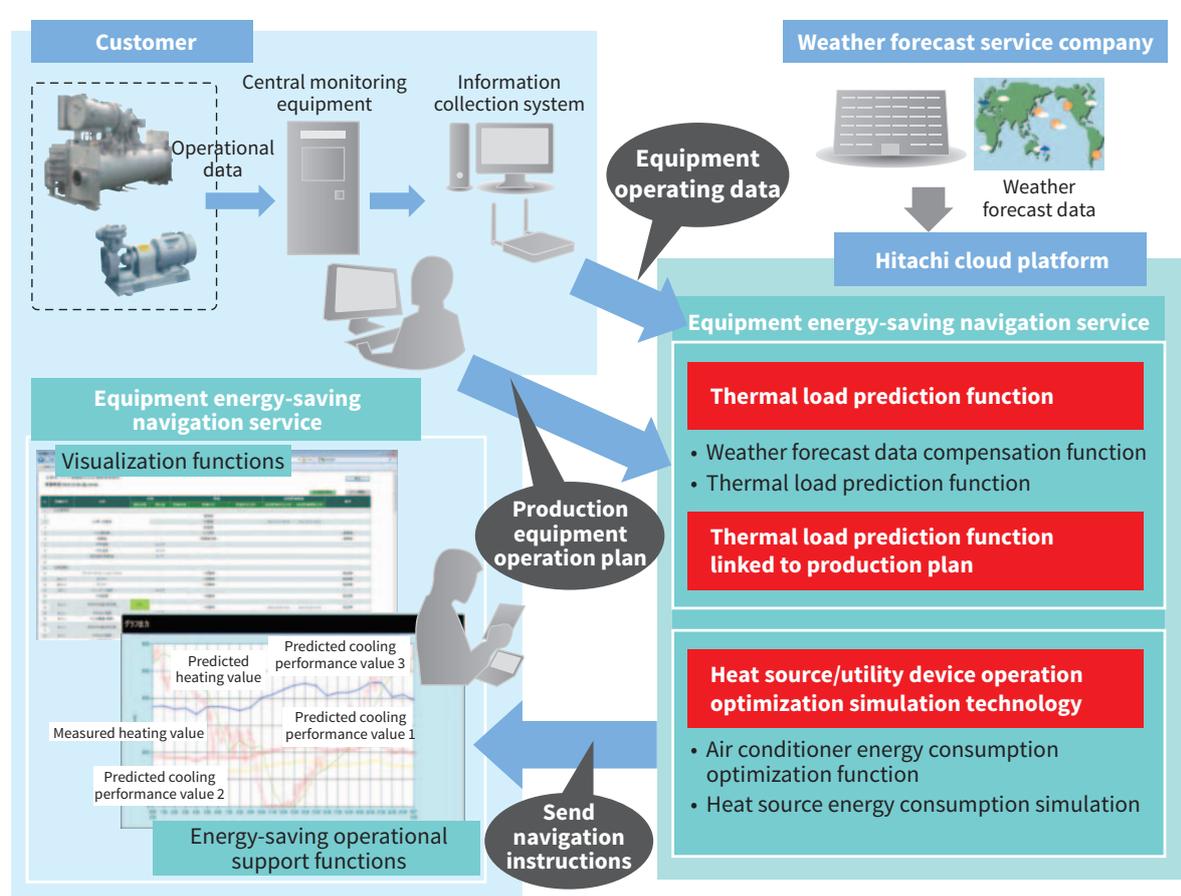
engineers retire, a skills vacuum is being created in the area of plant equipment management. Hitachi has responded by starting an energy-saving equipment guidance service that issues guidance about future equipment operation setting values using a function that predicts future load states, and technology that simulates optimum operation states by calculating characteristics of equipment and devices.

The accuracy of the service's load state predictions has been improved by using a correlation database of past production plans and load states, and adding a function that predicts future loads from entered production plan information. This functional expansion enables use of the system in plants where variable production previously made it difficult to predict future load states. Sending operation setting values designed to enable energy-saving operation of equipment and devices in future can help clients achieve energy- and cost-saving plant operation.

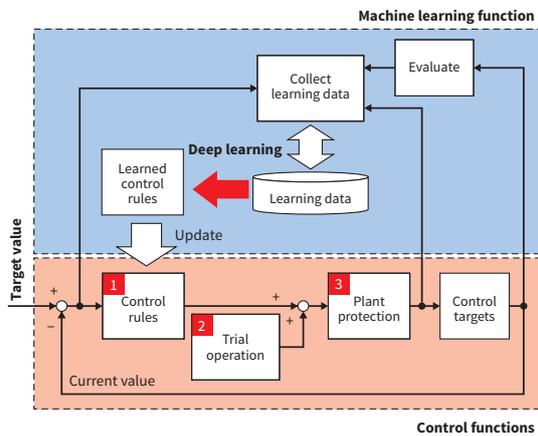
(Hitachi, Hitachi Plant Services Co., Ltd.)

8 Equipment Energy-saving Navigation Service Connected to Production Plans

Reducing plant operation costs is a major issue for manufacturers seeking competitive costs in global markets. Skilled engineers are needed to help ensure efficient operation, and as these



8 Energy-saving equipment guidance service overview.



9 Concept of the deep learning-driven control technology for steel plants.

9 Deep Learning-driven Control Technology for Steel Plants

Operator fine-tuning to handle complex shapes is a vital requirement when compensating for ruffling (shapes) in the steel plate produced by cold rolling mills. Product quality deviations due to differences in workload or operator expertise are therefore a major issue.

Hitachi has developed control technology that uses deep learning^{*1} to teach machines the operational expertise of skilled operators. It provides optimum correction of steel plate shape to create the target shape. Using a vast amount of past operational results data containing various complex shapes, the technology learns the relationships between operations and shape results as control rules in a neural network^{*2}, and provides automatic control using the learned neural network. Digitizing the operational expertise of skilled operators reduces operator workloads, while using machines to provide control by learning control rules from vast amounts of stored data improves product quality.

Demonstration testing of this technology started in mid-August 2017 at Beijing Shougang Co., Ltd.'s steelmaking plant in Qian'an. It is scheduled for commercial release in March 2018.

*1 A neural network machine learning method that increases the intermediate layer to enable expression of more complex models than before. Provides a high recognition rate in areas such as voice recognition and image recognition.

*2 A numerical model that simulates the structure of the neural pathways in the human brain. Neural networks have a structure composed of three layers (an input layer, intermediate layer, and output layer).

10 Tosyali Toyo Steel Starts Commercial Operation of Two Cold Rolling Lines

Tosyali Toyo Steel Co. Inc. is a steelmaker in Turkey that started trial operation of two cold rolling equipment lines in December 2016. One is a pickling line-tandem cold mill (PLTCM) that started commercial operation in March 2017. The other is a double cold reduction (DCR) facility that started commercial operation in April 2017.

Hitachi has constructed control systems for both facilities, delivering a HISEC-04/R900 controller enabling high-speed computations, high-performance, high-capacity insulated gate bipolar transistor (IGBT) drive equipment, low-capacity IGBT drive equipment, computer control equipment, control panels, and operation panels.

The facility's PLTCM uses a single reel to deliver the coil instead of the two reels used normally. It can be operated efficiently to reduce the footprint of equipment and to support production of non-rolled pickled coils using a take-up reel between the pickling line and rolling mill. The DCR facility is equipped with multiple operation patterns using two rolling mills, and supports tin-plated steel sheet applications that require minute and wide-ranging quality adjustments.

Hitachi's extensive experience was used to carry out trial operation of these cold rolling facilities efficiently and in parallel, rapidly achieving stable operation. The company will continue to produce systems supporting customer needs in markets throughout the world.



10 Control room during operation