ACTIVITIES

Realizing Carbon Reduction through Energy Solutions and Ultra-high-efficiency Products

IT Intelligence is Key

In "Hitachi Environmental Innovation 2050," Hitachi places importance on a low-carbon society as the ideal society to aim for. It has announced specific numerical targets to reduce CO_2 emissions by 80% (compared with FY2010) throughout the value chain by FY2050, and is rising to meet this challenge as a group. The key to achieving its goal is to reduce CO_2 emissions during the usage stage of products and solutions provided by Hitachi. This article examines the question of how it will advance these efforts. Kazunori Takahashi (Senior Manager, CSR and Environmental Strategy Division) discusses the background and approach to the low-carbon society that Hitachi is aiming for, specific business initiatives are discussed by Hiraku Ikeda (CSO, Power and Energy Business Administration Division) and Kenichi Souma (CTO, Hitachi Industrial Equipment Systems Co., Ltd.).

Hitachi's Low-carbon Mission

Hitachi announced that it will focus on the "realization of a low-carbon society" in its long-term environmental targets, "Hitachi Environmental Innovation 2050." Kazunori Takahashi, Senior Manager, CSR and Environmental Strategy Division, explains the reasoning for this as follows:

"Starting with the motor products Hitachi was founded on, products that use electricity have been the pillar of the company's business. Hitachi is also involved in power systems that produce electricity, so its business is closely tied to electric power. Therefore, reducing the carbon dioxide (CO_2) emissions of our products, that is, carbon reductions for energy as represented by electricity, is an essential element when considering Hitachi's contribution to solving climate change issues through business."

The highly ambitious goal of reducing CO_2 emissions in the Hitachi value chain by 80% overall by FY2050 compared with the FY2010 level represents Hitachi's sense of mission.

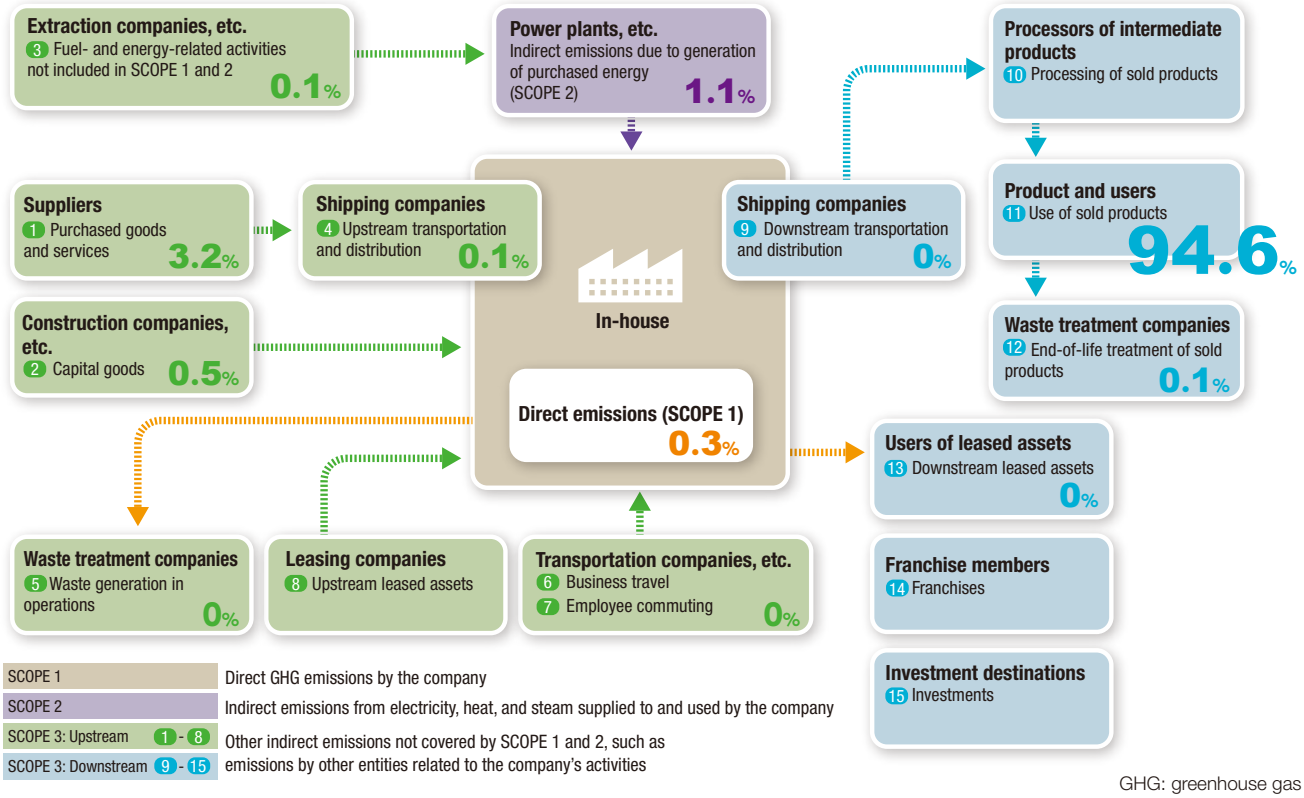
The value chain is the series of corporate activities related to products, services, and solutions provided by Hitachi, from the procurement of raw materials and parts to the production, transportation, use, disposal, and recycling of products. CO_2 emissions at the usage stage account for more than 90% of the total CO_2 emissions that are discharged at all stages of the value chain (see Figure 1).

Hitachi is also proceeding with issuing green procurement guidelines for supplier companies to reduce their environmental impact and reducing emissions at the production stage, but reductions at the usage stage are critical to achieving the company's goals.

To that end, "Hitachi Environmental Innovation 2050" cites four strategies (see page 14).

Figure 1 | GHG Emission Ratios throughout the Hitachi Value Chain

Emissions are calculated throughout the entire value chain to more effectively reduce these emissions. As over 90% of emissions come from the use of the products that it has sold, Hitachi is working to reduce emissions by developing Eco-Products that meet environmentally conscious criteria throughout their life cycle.



GHG: greenhouse gas

Senior Manager Takahashi says that he is currently focusing on the third goal, "development and diffusion of ultra-high-efficiency products and low-carbon energy," and the fourth, "cooperation and coordination between wide-area, complex systems."

"Transformation of business structures and the development of innovative materials with an eye toward next-generation technologies are issues that call for a long-term perspective. To accomplish these goals, we can promote our current business by providing ultra-high-efficiency products such as industrial equipment and home appliances and we can contribute to the spread of low-carbon energy such as nuclear power generation and renewable energy. In this way, we can fosters awareness of environmental problems. By combining and coordinating ultra-high-efficiency products, we aim to improve the efficiency of entire industrial and social systems."

Utilizing Knowledge Based on Lumada

The key to all of this is utilization of the Internet of Things (IoT). Digitalization has permeated today's society, so in addition to improving the efficiency of equipment itself, improving the efficiency of information technology (IT)—for example, by linking and coordinating products in a network—has a great effect.

According to Senior Manager Takahashi, "With our IoT-based 'system for electricity visualization,' the Hitachi Group has produced significant power-saving effects. Providing such knowledge as a solution and having it widely used by customers will lead to a lower-carbon society overall. In the IoT platform Lumada, the Hitachi Group is collaboratively creating solutions for customer problems by utilizing the latest technologies, such as artificial intelligence (AI) and analytics. We will also use Lumada to build up

specific initiatives within the Hitachi Group and our customers and accelerate carbon reduction through broad horizontal development of knowledge."

Diffusion of Low-carbon Energy Becoming a Global Trend

The main contributor to efforts aimed at reducing CO_2 emissions at the usage stage is the diffusion of low-carbon energy such as nuclear power generation and renewable energy. With the Paris Agreement coming into effect in November 2016, the entire world has steered toward countermeasures against global warming, and the spread of low-carbon energy is expected to become an increasingly global trend.

Hiraku Ikeda, Chief Strategy Officer (CSO) of Hitachi's Power and Energy Business Administration Division, sees domestic and overseas trends in light of the above as follows.

"In trends from before the Paris Agreement, the percentage of renewable energy increased in North America and Europe, photovoltaic power generation increased in areas near the equator, and nuclear power generation is expanding, primarily in emerging countries. From here on, microgrids that coordinate renewable energy with electric power grids and smart grids that enable the fine-tuning of the supply–demand balance will spread and lead to large-scale power sources being combined with distributed power sources."

What is the domestic situation in Japan?

"Domestically, we hope that utilization of IT will proceed through power system reform, leading to smarter operations. As part of the Paris Agreement, Japan announced its goal of reducing CO_2 emissions to 26% below 2013 levels by 2030. According to the Long-term Energy Supply and Demand Outlook by the Ministry of Economy, Trade and Industry in 2015, the energy mix in 2030 will be 22% to 24% renewable energy and 20% to 22% nuclear power generation. In sum, we can say that further increases in renewable energy and restarting our nuclear power plants will be indispensable to reducing CO_2 emissions."

Boosting Popularization of Low-carbon Energy with Solutions for Power System Stabilization

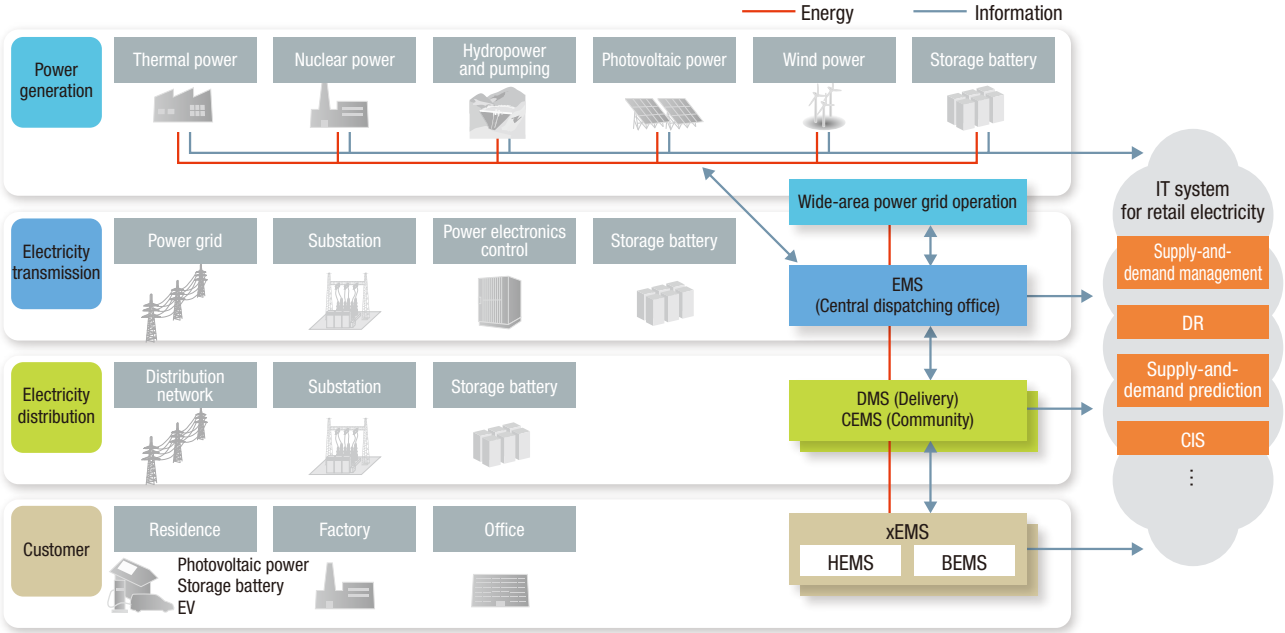
Since its founding, Hitachi has worked on power-related equipment such as transformers and circuit breakers, and it has been supporting electric power system for many years since. Hitachi also provides a wide range of products and solutions that support the spread of low-carbon energy.

Among the various forms of renewable energy, photovoltaic and wind power generation are unstable power sources because their levels of power generation depend on the weather. Sharp fluctuations in the amount of electricity generation can disturb the supply-and-demand balance, and fluctuations in frequency and voltage can lead to power outages. The higher the proportion of renewable energy in the power grid, the higher the risk. For that reason, CSO Ikeda states that "we require measures for absorbing power generation fluctuations, such as the introduction of large storage batteries and strengthening and wide-area operation of the power transmission network" (see Figure 2).

"There are many related technologies, but, to give one example, high-voltage direct current (DC) power transmission technologies are attracting attention in the improvement of power transmission networks and their wide-area operation. These technologies are effective for long-distance power transmission—for example, when building offshore wind power plants in places where the natural conditions are most suitable, such as Hokkaido, Tohoku, and Kyushu, and then directly sending power to areas of large consumption such as Tokyo and Osaka. Hitachi established a joint venture with ABB in the Swiss Confederation, a company that has a proven track record in this field and offers high-voltage DC power transmission systems for domestic use. Through the provision of power system stabilization solutions that combine these technologies and systems, we are contributing to the utilization of renewable energy."

Figure 2| Hitachi's Power and Energy Solutions

Hitachi provides total solutions, from power generation to transmission, distribution, and IT systems for electricity retailing.



BEMS: building energy management system CEMS: community energy management system CIS: customer information system
DMS: distribution management system DR: demand response EMS: energy management system EV: electric vehicle
HEMS: home energy management system IT: information technology

There are various other technologies for stabilizing the power system, including microgrids and demand-side management (DSM), where the power supply side controls demand-side power consumption to some extent. Another is virtual power plants (VPPs), which enables distributed power sources on the power grid to function like a single plant. A major strength of Hitachi is that it has both wind power and photovoltaic system components and the technologies to utilize them stably, and by combining these two, it can provide them as a solution.

Collaborative Creation toward a Low-carbon Society

Big data analysis, the IoT, and AI are essential elements in power system stabilization. To give an example of utilizing big data analysis and the IoT, Hitachi provides systems that use actual electric power system data to instantaneously find sites of incidents affecting the system, such as the locations of lightning strikes, and perform calculations to determine measures to protect the system in real time.

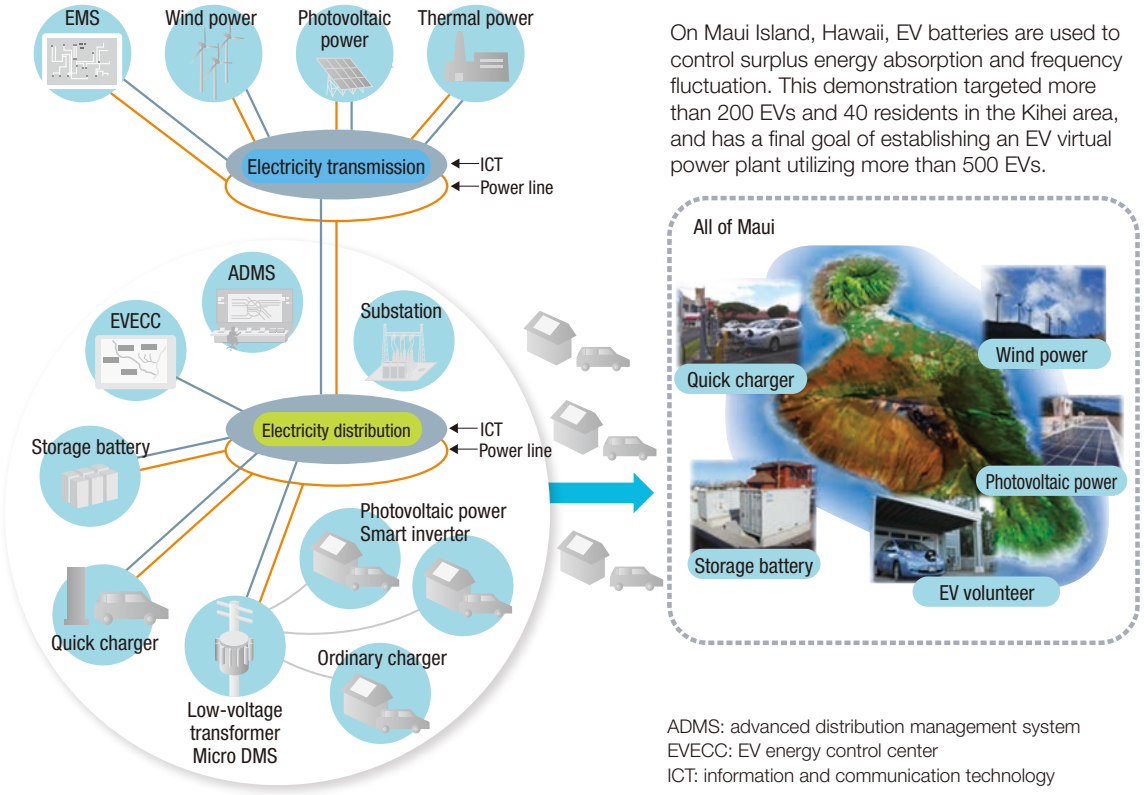
CSO Ikeda expresses his hopes for IT utilization as follows: "The IoT is indispensable for advanced power system technologies such as DSM and VPPs, remote control of power generation equipment, predictive diagnosis of failure indicators, collection of power usage data by smart meters, and the operation of smart grids. In the future, using AI will allow us to find new approaches such as advanced energy management."

One case of an energy solution utilizing IT is a demonstration project by the New Energy and Industrial Technology Development Organization in Hawaii, USA.

Through the use of electric vehicles as storage batteries, this project investigated smart grid technologies that realize efficient use of renewable energy and respond to supply–demand fluctuations (see Figure 3).

In Greater Manchester, UK, Hitachi similarly participated in a smart community demonstration

Figure 3| Smart Grid Demonstration Project in Maui, Hawaii, USA



On Maui Island, Hawaii, EV batteries are used to control surplus energy absorption and frequency fluctuation. This demonstration targeted more than 200 EVs and 40 residents in the Kihei area, and has a final goal of establishing an EV virtual power plant utilizing more than 500 EVs.

ADMS: advanced distribution management system
EVECC: EV energy control center
ICT: information and communication technology

project that coordinates power supply and demand across an entire area, including homes. The broader aim is to provide energy solutions both in Japan and abroad, while also utilizing technologies and systems demonstrated in these efforts.

According to CSO Ikeda, "Efforts toward the spread of low-carbon energy are the core business of companies involved in electricity supply and are closely related to consumers' lives. Challenges arising as a result of such initiatives will vary, depending on the region and the company. The collaborative creation approach that Hitachi is advancing comes to life in such situations. We discover customer problems, and using Lumada as a base, we collaboratively create low-carbon energy solutions that resolve issues by combining IT with the knowledge of power system operational technology (OT) that is shared by customers and Hitachi. This enhances the corporate value of our customers and, as a result, will lead to reduced CO_2 emissions through Hitachi's products and solutions."

While the road to achieving our 2050 target may be a bumpy one, steady accumulation of each element will undoubtedly produce significant results.

Aiming for Synergistic Effects with High Efficiency, Compactness, and Reduced Weight

Another important factor in reducing CO_2 emissions at the product usage stage is ultra-high-efficiency products. The Hitachi Group offers a wide range of products, each of which continues to pursue high efficiency. Among these products, however, industrial electric products such as motors, transformers, air compressors, and pumps are expected to produce a great effect (see Figure 4).

Improved efficiency is a widely used foundation for industry and daily life—from industrial manufacturing plants to electric power and water systems, building facilities, and household appliances—so the effects of improved efficiency extend to all sectors of society.

Figure 4| Hitachi's Energy-saving Solutions

The Hitachi Group contributes to reducing CO_2 emissions at the usage stage through ultra-efficient industrial products such as transformers, motors, inverters, pumps, blowers, and air compressors.

CO_2: carbon dioxide PM: permanent magnet

Kenichi Souma, Chief Technology Officer (CTO) of Hitachi Industrial Equipment Systems Co., Ltd., concurrently serves as General Manager of the Research & Development Division of the Industrial Products Business Unit, both of which handle these products. He oversees technology development in collaboration with group companies and departments related to parts and materials.

Regarding the effect of improving the efficiency of industrial electronics products, Souma says, "Over the past 100 years, through improvements in materials and the sophistication of design technologies, Hitachi has achieved dramatically higher efficiency, greater compactness, and lighter weight for motors, its original product. Compactness and light weight not only lead to resource savings but also increases transportation efficiency. Moreover, highly efficient, smaller, and lighter motors improve the efficiency, size, and weight of equipment using the motors, so there is an increasingly large synergistic effect for reducing CO_2 emissions. There are survey results indicating that electricity consumed by motors accounts for about 60% of the total consumption in Japan and about 40% worldwide. Because motors are so widely used, we can say that they play a large role in improving environmental performance."

Amorphous Transformers and Other Unique High-efficiency Technologies

Hitachi has also achieved high efficiency in transformers, which are indispensable for supplying electric power to industrial equipment, including motors. Amorphous transformers drastically reduce no-load loss (standby power) by using an amorphous alloy in their cores, through which magnetic flux passes.

Amorphous alloys are alloys that do not have a crystalline structure like ordinary metals. They have excellent electrical characteristics, but are problematic in that their machining is difficult.

As CTO Souma emphasizes, "Because these alloys require advanced technology for their machining, only Hitachi, which its abundant global achievements, can make amorphous transformers with high reliability. The effect of reducing no-load loss is significant—when we replaced all the old transformers with amorphous transformers at the Nakajo Division of Hitachi Industrial Equipment Systems Co., Ltd., we were able to reduce our annual electricity consumption by two-thirds."

Because transformers are products that are used for a long period of time, such as 20 or 30 years, their effect on reducing CO_2 emissions are extremely high. Many pieces of social and industrial infrastructure will need to be replaced over the next several years, and Hitachi is actively promoting the merits of introducing amorphous transformers.

Hitachi is further expanding this technology by developing an amorphous motor that combines a ferrite magnet and an amorphous core. The most recent type is thin, yet achieves an efficiency of 96% to 97%, giving them a ranking in the International Energy Efficiency Code (IE) of IE5, which is being developed as the highest international efficiency standard for industrial motors. Hitachi is planning to offer products with thin, high-efficiency characteristics, including compressors that realize significantly reduced size through use of these motors.

Improving Efficiency by Installing Inverters

According to CTO Souma, motors can achieve further reductions in power consumption according to how they are used.

"The key point is utilizing inverters. The pumps and fans run by the motor produce a lot of waste. This is because the rotational speed of the motor is constant, while the flow rate of water and air is controlled by opening and closing a valve. If the rotational speed of the motor can be varied through combination with inverters, we can reduce rotations to 80% when an 80% flow rate is sufficient. The power consumption of a motor increases in proportion to the cube of rotational speed, so even slightly lowering the rotational speed results in large energy savings."

The term "inverter" is commonly heard, which may give the impression that they are commonly used, but their installation rate for fans, pumps, and compressors is only 17% (according to a FY2014 survey by The Japan Electric Manufacturers' Association). There is much room for reducing power consumption by promoting inverter use alongside improving motor efficiency. Hitachi provides not only single-inverter units but also various types of inverter-integrated equipment, thereby encouraging their popularization by reducing the efforts involved in introducing them to customers.

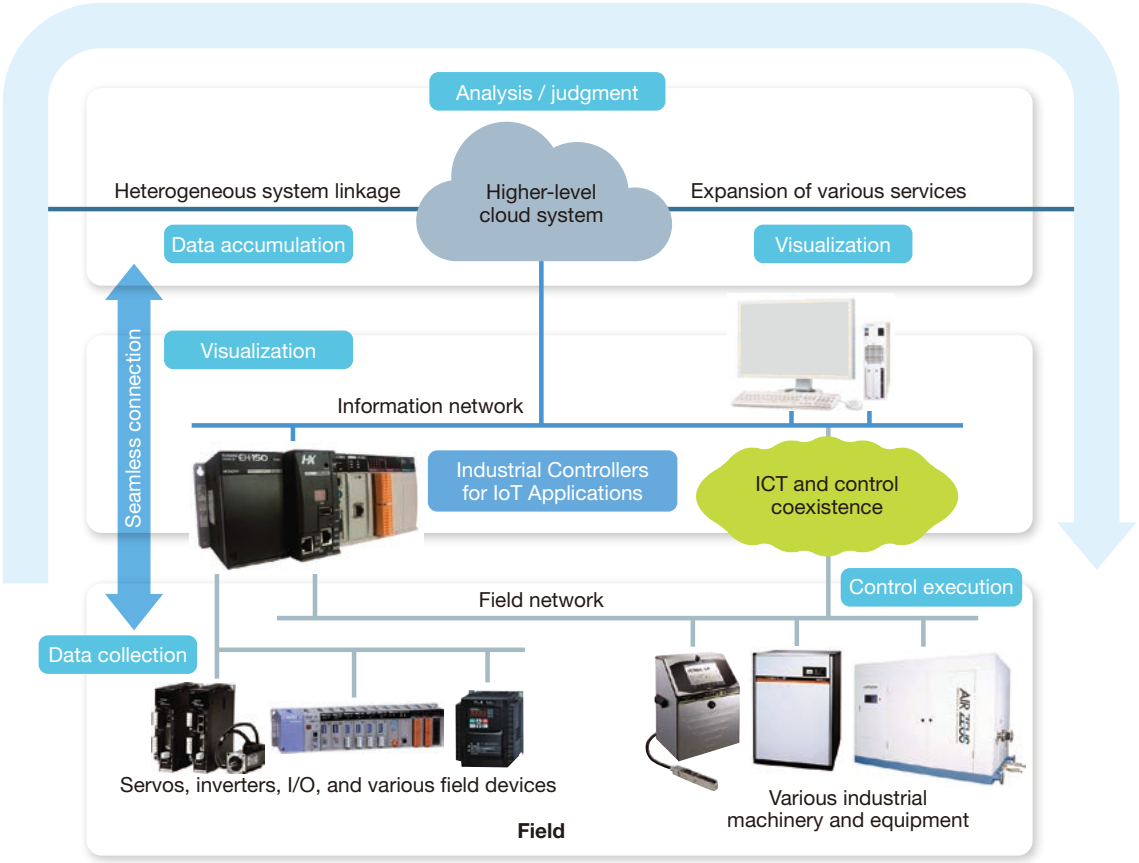
Ongoing Evolution of Motors and Transformers

Hitachi is also starting to utilize the IoT in reducing power consumption according to how equipment is used. CTO Souma's outlook is as follows:

"In industrial fields, a fourth industrial revolution has begun, one in which advances in automated production facilities go one step further, connecting all equipment and even people in a network to realize smarter manufacturing. With the IoT and AI, we can of course automatically and optimally control air conditioning by watching various on-site data, or efficiently move energy on production lines, but in the future, we will be able to expand this connection to multiple factories in Japan and abroad. We believe that this will allow selecting the factories most optimal for a given time from the viewpoints of CO_2 emissions, transportation, procurement efficiency, and so on," (See Figure 5).

Figure 5| **Hitachi's Smart Manufacturing**

The Hitachi Group proposes smart manufacturing that simultaneously realizes high-performance control and seamless networks in response to IoT trends in industrial fields.



I/O: input/output IoT: Internet of Things

Furthermore, by using Lumada to collect and analyze data on the production and usage process of equipment, Hitachi can surely improve the efficiency of design and manufacturing processes and increase productivity, as well as produce previously unknown ideas for high efficiency.

CTO Souma says, "Motors and transformers are unassuming products, but there is still plenty of room for their further evolution, allowing them to contribute toward reducing CO_2." The evolution of Hitachi's founding products thus still has great potential for leading toward innovation of society as a whole.

This article has introduced how Hitachi will contribute to an overall low-carbon society by promoting thorough reduction of CO_2 emissions both on the energy supply side, such as power generation and transmission, and on the demand side, which enables industries and society to function through energy utilization. By making global environmental problems a driving force for innovation and by assuming its mission as a leader in a sustainable society, Hitachi will continue to make constant efforts toward solving the social issues of the future.