Section 3

Creating Value from Customers' Perspectives

- Ebara's Business -

The Ebara Group has been refining its technologies for over 110 years, and it has garnered the close trust of industry and customers as a "public institution."

In January 2023, the Company changed from a traditional product-based organization to a target market-based organization that focuses on customers' perspectives.

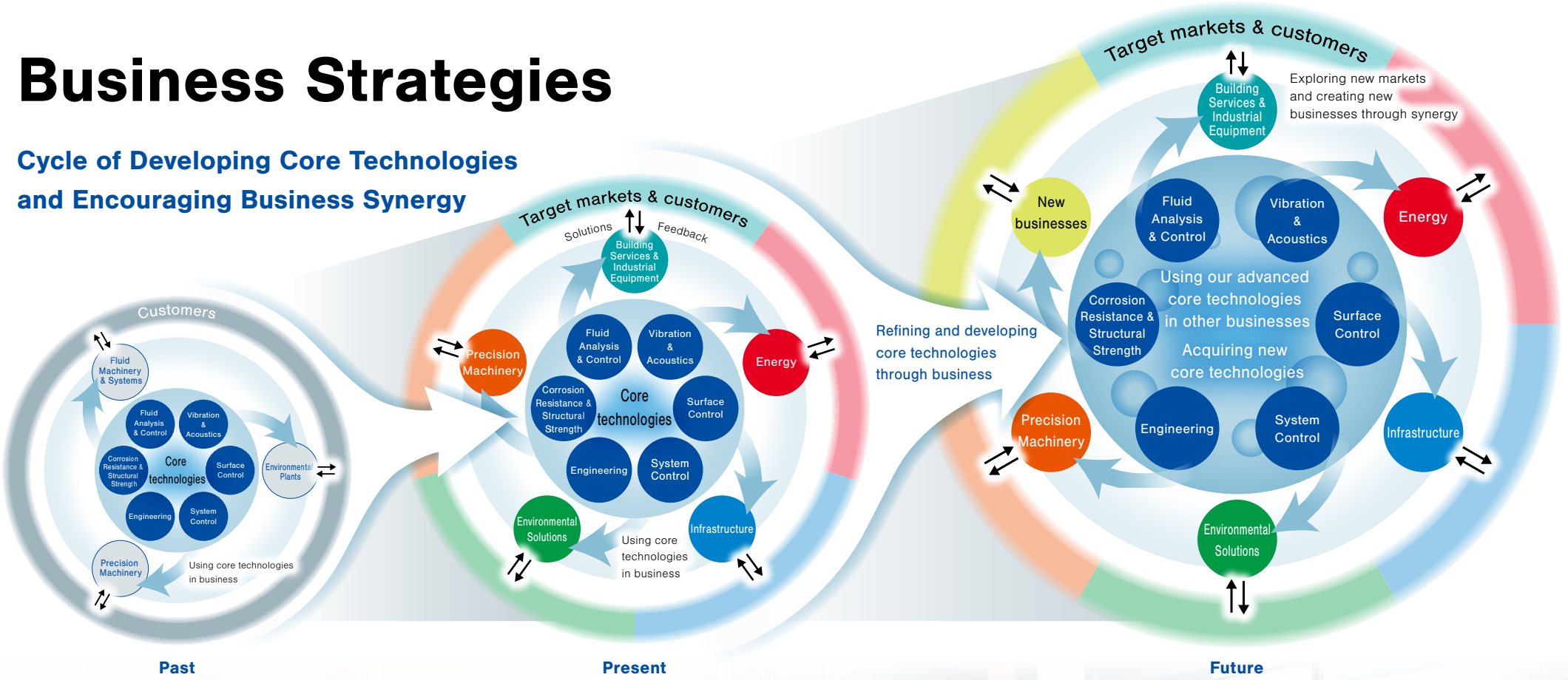
We intend to continue creating value by enhancing our market-oriented approach and by altering the entire company's organizational structure to sincerely address customer requests and issues.

On to the wider world, the next generation, and the future of our planet...

With an even broader perspective, we will deliver Ebara's value to unexplored areas as well.

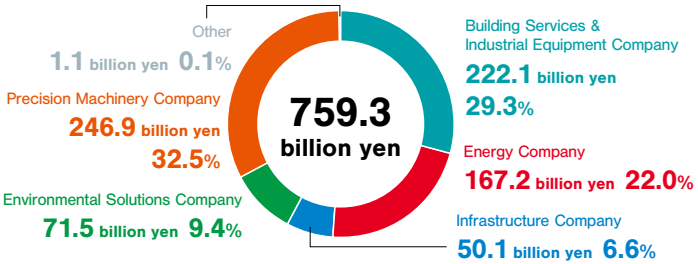
Business Strategies

Cycle of Developing Core Technologies and Encouraging Business Synergy

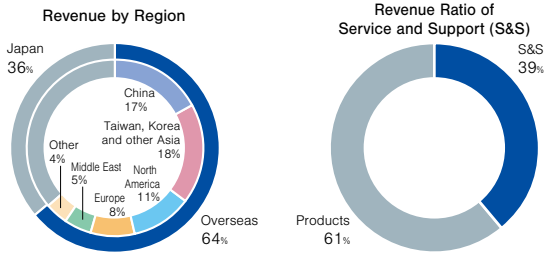


One of the Ebara Group's distinctive strengths is its comprehensive ability to provide solutions required by the times with products and services created using core technologies that have been refined over time and to further develop core technologies and create new businesses based on feedback from customers in target markets. We will continue to seek to provide higher value-added solutions using our core technologies, and we will provide the world with value that only the Ebara Group can offer while further developing our core technologies and acquiring new core technologies.

2023 Consolidated Revenue by In-house Company



Consolidated Results



Business Strategies

Building Service & Industrial Company

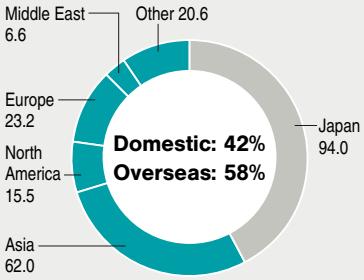
Business Vision (E-Vision 2030)

We will aim to be a solution service provider that solves water supply and thermal energy issues in the building and industrial equipment markets.

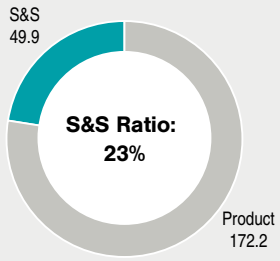
Company Information

Main Target Markets	• Building equipment • Industrial equipment
Main Products	• Standard pumps • Fans • Chillers • Cooling towers
Market Share and Main Achievements	• Standard pumps: #1 domestic share • Cooling towers: #1 domestic share Note: Ebara survey
Competitors	• Standard pumps: Grundfos, Xylem, Kawamoto Pump Mfg., Tsurumi Manufacturing, etc. • Chillers/Cooling towers: Carrier (chillers), YORK (chillers), Kuken Industries (cooling towers), etc.

Revenue by Region (Billions of yen)



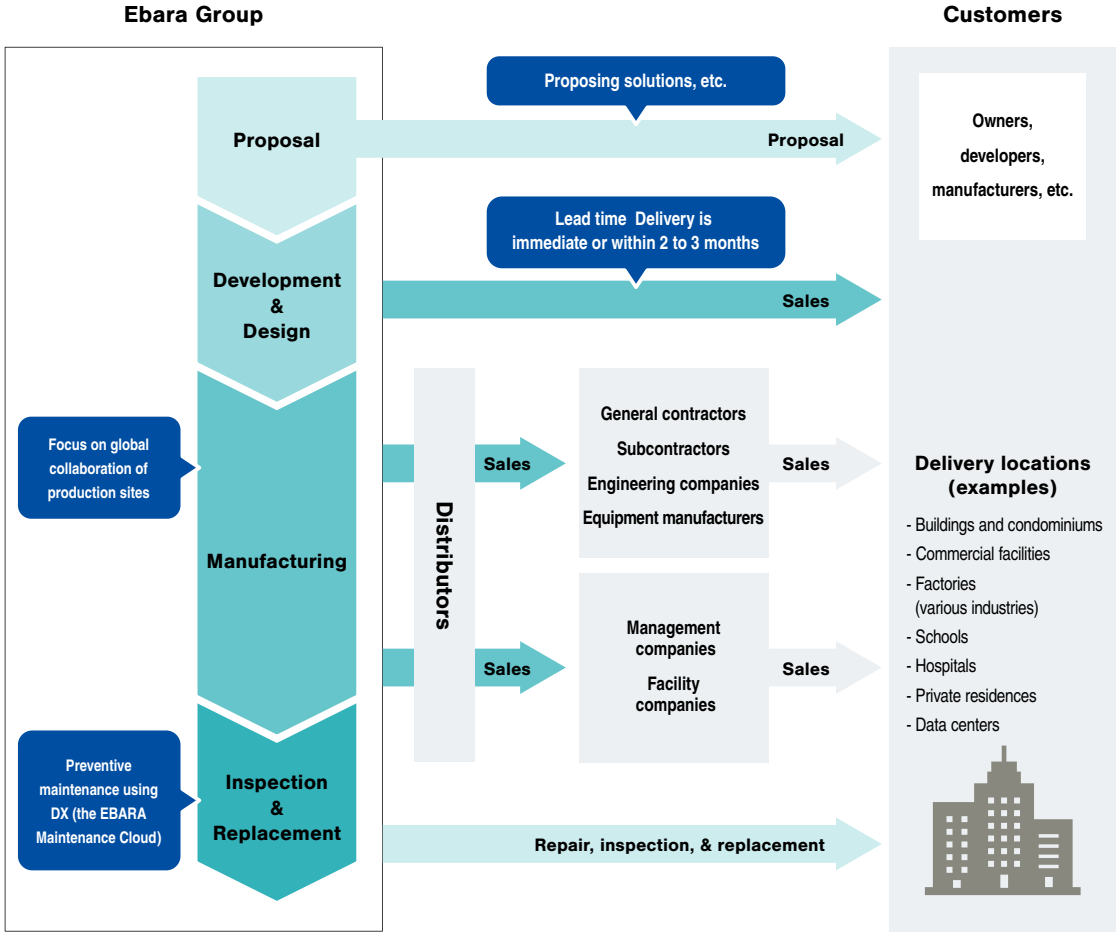
S&S Revenue Ratio (Billions of yen)



Note: The above graph displays actual figures for the fiscal year ended December 31, 2023.

Company Characteristics and Business Flow

- Sell through construction companies, facility installation companies, and distributors/partners
- Relatively short lead time
- Focus on providing integrated hardware & software solutions using DX



Building Service & Industrial Company

We will drive the Group's growth by creating new solutions with our outstanding product lineup and global collaboration.

The key issues for E-Plan 2025 are the expansion of our solutions business and entry into the growing foreign and industrial equipment markets. 2023, which was the first year of the plan, was a year in which we were able to see how our products were being used and our customers' needs and issues amidst solid global demand.

We will continue to promote organizational and functional integration based on target markets, improve our ability to propose total solutions spanning products, and create new business models. We will specifically focus on improving products and services that greatly help to solve customer issues, such as the EBARA Maintenance Cloud, developing products with inverters that help to reduce energy consumption, and developing products and identifying customers to garner demand in high-value-added areas such as semiconductors, pharmaceuticals, and functional chemicals. To that end, we will enhance collaboration within the Group, improve our production efficiency and development capabilities, and improve our sales capabilities based on proposals, including the global roll out of products from the companies we acquired. In addition, we will acquire and train human resources with expertise in digital technology and AI and actively cooperate and form business alliances with other companies to further accelerate our business growth.

Shu Nagata

Executive Officer
President, Building Service & Industrial Company

Market Environment

Opportunities

- Increase in water demand attributable to population and economic growth in emerging countries
- Increase in collective housing and buildings due to population concentration in cities
- Increase in demand for irrigation and drainage equipment due to climate change
- Increase in demand due to growth in advanced industries such as semiconductors
- New opportunities arising from industrial structure changes occurring in conjunction with decarbonization and progress in 5G, IoT, and other technologies

Threats

- Intensification of price competition stemming from domestic market contraction
- Increased competition due to maturity of technologies and improvement of technological capabilities of emerging manufacturers
- Supply chain disruptions due to geopolitical risks

Our Strengths

- Fluid, numerical analysis, material, analytical, and other fundamental technologies
- Capability for developing highly efficient, high-quality, and highly reliable products
- Diverse global employee base and network
- Strong presence in Japan and Asia
- Broad product lineup

Basic Strategies of E-Plan 2025

1 Strengthen solution business

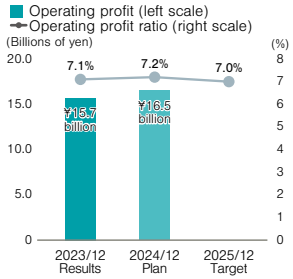
2 Capture (overseas) growth markets

3 Rebuild global business infrastructure

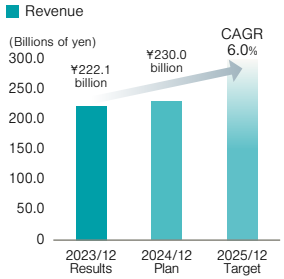
We aim to grow our business further by providing new solutions combining pumps, chillers, and services from customers' perspectives in the building and industrial equipment markets. We will also continue to upgrade and streamline tasks and business management through DX.

Financial Targets and Results

Operating Profit Ratio: 7.0% or higher



Revenue CAGR: 6.0% or higher



Non-financial Goals, KPIs, and Targets

Related Materiality	2025 Outcome Goals	KPIs	2025/12 Targets	2023/12 Results	Measures and Future Initiatives
1 Contribute to the creation of a sustainable society	Reduce GHG emissions	Unit sales of energy-saving, highly efficient products	15% increase compared to 2022	8% increase compared to 2022	Launch and expand sales of products that reduce GHG emissions
	Deliver water to 500 million people	Unit sales of solar pumps	50% increase compared to 2022	20% decrease compared to 2022	- Expand product lineup - Focus on sales in South America and Africa
		Unit sales in emerging countries	40% increase compared to 2022	1% increase compared to 2022	- Launch and expand sales of products that meet the differing needs of each region - Establish bases in Africa, South America, etc.

Building Service & Industrial Company

2023 Results and Future Challenges

Basic Strategies 1

Strengthen solution business

Results

- Sales of products with reduced energy consumption and a low environmental impact, such as water supply units, remained strong.
- Integrated several remote monitoring systems for individual products, and completed a system that allows them all to be monitored using the EBARA Maintenance Cloud.
- Expanded contact with the market by improving proposals to customers that are equipment manufacturers.

Future Challenges

- Accelerating functional integration of pumps, cooling towers, and blowers.
- Enhancing our lineup of products with reduced energy consumption and a low environmental impact, such as pumps with inverters and water supply units.
- Improving and adding value to the EBARA Maintenance Cloud service.

Basic Strategies 2

Capture (overseas) growth markets

Results

- Sales to industrial customers in China remained strong.
- Established a new branch in Sweden. Identified new customers in Mexico and Africa, where we established subsidiaries under the previous medium-term plan.
- Acquired the immersion pump business of the German company SKF.

Future Challenges

- Accelerating expansion of our lineup of products for the industrial equipment market (e.g., chillers for the semiconductor market) and development of sales channels.
- Using Group companies to globally market products from the companies we acquired.

Basic Strategies 3

Rebuild global business infrastructure

Results

- Focused on resuming parts procurement following the COVID-19 pandemic and ensuring a consistent supply of products.
- Enhanced collaboration among production sites and created a system that facilitates working together to improve production, reduce losses, and optimize inventory levels.

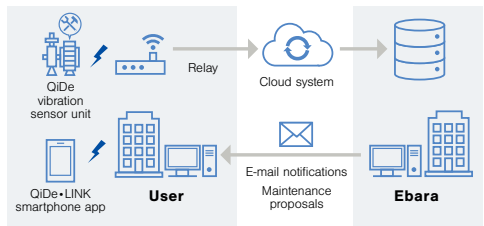
Future Challenges

- Enhancing collaboration between domestic and overseas production sites and promoting steps to increase profits.
- Managing accounts receivable and inventory at appropriate levels and seeking to expand sales while maintaining an appropriate balance.

Value Creation

EBARA Maintenance Cloud

Facilitating DX at the customer's site through integrated hardware and software



With the declining birthrate and aging working population, issues such as labor shortages and rising labor costs have become apparent. Reduced labor and lower costs are needed in facilities management. Launched in 2022, the EBARA Maintenance Cloud is a remote monitoring service that helps to solve these issues. Wireless sensors are installed on pumps, blowers, and cooling towers, regardless of whether they were manufactured by us or other companies, and their operational data is remotely monitored in real time in the cloud.

An easy-to-use app allows users to manage and analyze accumulated data in the cloud via easily operated, inexpensive, and compact sensors we developed. By rapidly detecting signs of abnormalities or faults and notifying the user, this system reduces the inspection time and labor costs and it minimizes opportunity losses due to sudden faults. In addition, we have completed the development of a feature to incorporate operational data from chillers and water supply units. In the future, we will provide solutions for highly efficient facility operation by comprehensively analyzing accumulated data from various facilities while making full use of the fluid machinery and systems technology we have developed, thus helping to decarbonize our customers' operations.

Interview

Connecting with customers and the market through "pumps that link users to Ebara"

We engage in marketing, development, and expansion of sales while always being mindful of "What is the customer's true problem?" and "Will the product, service, or technology benefit the customer and us?" The concept behind this approach is "pumps that link users to Ebara." With distribution channels in the past, determining how the equipment we delivered was being used by our customers was difficult, but now we can provide a sense of security because "Ebara is looking out for you." This is achieved by directly connecting us to users through sensors and the cloud. Our products operate efficiently without stopping and they help to optimize resources on-site. We want to instill this impression of our brand and continue to be in a position where customers naturally call on us when upgrading.

Bunshi Ono
Smart Solution Section,
Sales Strategy Promotion Department,
Domestic Business Division

Yasumasa Yamada
Solution System Development Section,
Domestic Business Development Department,
Development Division

Business Strategies

Energy Company

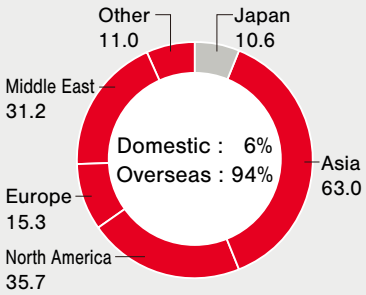
Business Vision (E-Vision 2030)

Be the best solution provider in the energy sector by providing premier equipment and service, while actively leading sustainability efforts worldwide.

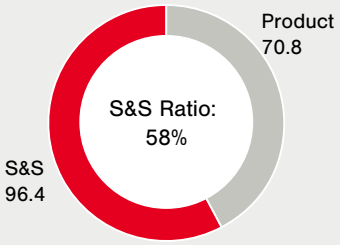
Company Information

Main Target Markets	• Oil & Gas • Petrochemicals • Refining • Power Generation • Fertilizer • New Energy
Main Products	• Compressors and Turbines • Custom pumps • Cryogenic Pumps • Expanders
Market Share and Main Achievements	• Top global share in Cryogenic Pumps & Expanders for LNG plants • Top global share in Oil & Gas plant (downstream) compressors • Pumps for fertilizer plants: Top share worldwide Note: EBARA survey
Production Bases	• Japan: Sodegaura Plant, Futtsu Plant • Overseas: Elliott Company (US), Elliott Ebara Turbomachinery India (India), EBARA GREAT PUMPS CO. (China), EBARA MACHINERY ZIBO CO. (China)
Competitors	• Japan: Nikkiso, Mitsubishi Heavy Industries Compressor • Overseas: Baker Hughes (US), Flowserve (US), KSB (Germany), Siemens Energy (Germany), Sulzer (Switzerland)

Revenue by Region (Billions of yen)



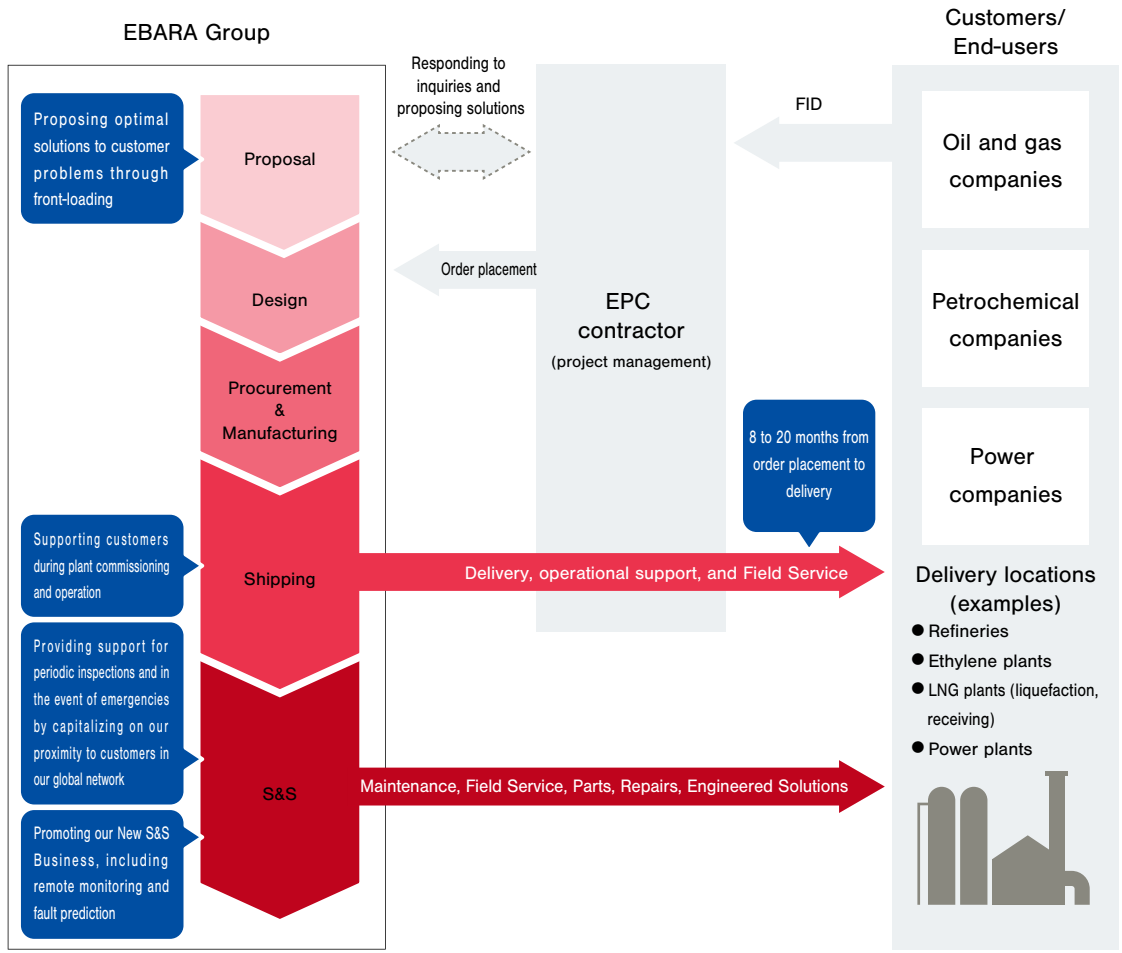
S&S Revenue Ratio (Billions of yen)



Note: The above graph displays actual figures for the fiscal year ending December 31, 2023.

Company Characteristics and Business Flow

- After the end user makes a final investment decision (FID), the project is awarded through an engineering, procurement and construction (EPC) contractor (talks may take place directly with the end user)
- A wide range of support, from delivery of equipment, assistance with operation, inspections and maintenance after the start of operations, and modifications to increase capacity



Business Strategies

Energy Company

Combining the Group's strengths, we will create new value required by the market for next-generation energy.

The business environment in the energy market is undergoing a period of major change. As that happens, our Energy Company is providing the best solutions to address changes in society and customers in the energy field to create value starting with the customer in its main target markets of oil & gas, power, and next-generation energy.

In 2023, the Company continued to integrate its existing Custom Pump business with its Compressor & Turbine business. The Company demonstrated its combined strength of a solid global business foundation and a broad product lineup, and it met customers' needs. In addition to promoting automated design and manufacturing via DX and use of AI, we are also working to further improve the profitability of existing businesses by restructuring our global production system and implementing structural reforms to take advantage of the characteristics of each site from the perspective of the customer and the market and by optimizing business locations by establishing new service sites or consolidating existing sites.

In the area of sustainability, we are steadily creating new business models such as remote monitoring and fault prediction in addition to developing products for ammonia, CCUS*, and hydrogen and expanding our product lineup in response to the energy transition.

We will create new value required in the next-generation energy market and lead the building of a sustainable society as the "best solution provider."

*CCUS: Carbon capture, utilization, and storage

Takanobu Miyaki

Executive Officer
President,
Energy Company

Market Environment

Opportunities

- Increased demand for LNG in the short- to medium-term
- Increased demand for fossil fuels in line with population growth in emerging countries
- Growth in renewable and new energy markets such as CCUS, hydrogen, geothermal, and ammonia
- New S&S demand due to lack of personnel, aging population, and aging equipment at customer facilities and plants

Threats

- Uncertainty in the oil and gas market due to geopolitical risks
- Possibility of the oil and gas market shrinking over the medium- to long-term
- Increased costs for procurement and manufacturing due to geopolitical risks
- Intensifying price competition due to maturation of technology and improved technological capabilities of competitors

Our Strengths

- Abundant track record and cultivated trust for use in important equipment such as compressors for LNG and ethylene, turbines, custom pumps
- Close proximity to end users; EPC; and process licensors
- Providing comprehensive, quality services and support
- Excellent high-speed rotating machinery technology, verylow-temperature technology, materials technology, and production technology
- A strong global network through the integration of our custom pumps business and compressors & turbines business

Basic Strategies of E-Plan 2025

1 Establish new business models in the areas of sustainability and services to lead the shift to renewable energy and contribute to decarbonization

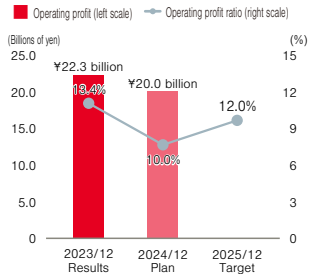
2 Make structural reforms to further improve profitability in existing business areas

3 Integrate Compressors & Turbines and Custom Pumps to deliver new value to customers and markets

In light of the megatrends of decarbonization and next-generation energy, we are promoting solutions that respond to changes in customers and society. We intend to provide solutions that highlight our strengths as a result of integrating compressors/turbines and custom pumps, and we intend for our business to "become a new growth business" that addresses changes in customers and society. In addition to further improving the profitability of our existing businesses, we are also working to create new business models in the areas of sustainability and services.

Financial Targets and Results

Operating Profit Ratio: 12.0% or higher



Non-Financial Goals, KPIs, and Targets

Related Materiality	2025 Outcome Goals	KPIs	2025/12 Targets	2023/12 Results	Measures and Future Initiatives
1 Contribute to the creation of a sustainable society	Reduce GHG emissions	Development and sales promotion of new pumps (ammonia pumps, injection pumps, etc.) for the decarbonization market	Achieve 100% of commercialization and sales targets	Completed product launch	Introduce products that reduce GHG emissions to the market and expand sales
		Development of new compressors for the decarbonization market	Achieve 100% commercialization	Continued product development	Promote R&D including resources

Business Strategies

Energy Company

2023 Results and Future Challenges

Basic Strategies 1

Establish new business models in the areas of sustainability and services to lead the shift to renewable energy and contribute to decarbonization

Results

- Established a specialized department to develop business in the area of sustainability and to build medium- to long-term relationships with customers.
- Launched canned motor pumps for liquid ammonia, which is expected to be used as a carbon-free fuel. Developed new compressor models for CCUS and hydrogen.
- Received a compressor order for the first sustainable aviation fuel (SAF) project in Thailand.
- Our New S&S Business began delivering the Gemini compressor monitoring system to customers.

Future Challenges

- Actively investing in R&D in new markets and focusing on developing products for decarbonization and developing our New S&S Business.

Basic Strategies 2

Make structural reforms to further improve profitability in existing business areas

Results

- Steadily improved productivity through automation and modernization of production facilities at the US plant.
- Accelerated site selection and consolidation to improve the profitability of the S&S business. We closed unprofitable locations, but we expanded our flagship service center in the US and we finished construction of new service locations in Southeast Asia.

Future Challenges

- From the perspective of the customer and the market, we intend to restructure and optimize the global engineering and production system by taking advantage of the characteristics of each site in the US, Japan, China, and India.
- Further improving the profitability of existing businesses by promoting more efficient design and the automation of manufacturing via DX and use of AI.

Basic Strategies 3

Integrate Compressors & Turbines and Custom Pumps to deliver new value to customers and markets

Results

- In January 2024, Elliott Group Holdings, a business management company under the Energy Company, changed its name to Ebara Elliott Energy Holdings, Inc. Rebranded as EBARA Elliott Energy, embodying the integration of conventional Compressors & Turbines with Custom Pumps.

Future Challenges

- Planning and implementing specific actions to maximize the utilization of each of the Energy Company's sites (manufacturing and service locations).
- Further creating a combined synergy (maximizing added value and minimizing costs)

Value Creation 熱と誠

Developing a canned motor pump for liquid ammonia

Helping to create a decarbonized society through the ammonia supply chain

Amidst the global trend toward decarbonization, studies are underway, particularly in Japan, to use ammonia as an effective fuel to combat global warming since it emits no CO_2 when burned. Ammonia is garnering attention as an energy carrier to transport hydrogen, but its toxicity and odor mean that leaks need to be prevented when it is handled. In 2023, we completed the development of a canned motor pump with a new structure that does not leak the handled liquid, and we are focusing on closing orders.

The construction of ammonia fuel terminals, power generation plants using ammonia, and ammonia-fired thermal power plants, which help to reduce CO_2, is expected to increase in the future, and demand for leak-free pumps is expected to grow accordingly. Through these products, we will contribute to the overall supply chain of "making," "transporting," and "using" ammonia. →P81

Interview

Creating new markets to "Support our globe" in the future

The ammonia fuel market itself is in its formative stages, and determining target customers for our products was difficult. However, the marketing and product development departments worked together to glean the true opinions of customers and other stakeholders as much as possible and to reflect them in our products. In addition, we actually met with customers face to face to discuss the products, and we endeavored to create products that they truly wanted. Our products are but one part of a long supply chain, but they are an essential one. We want to create the decarbonized society of the future by properly putting all of those pieces together. Our raison d'etre is "Technology. Passion. Support our Globe." and we will continue to provide the best products from the perspectives of our customers and the market.

Masahito Suzuki
Marketing Section, Sustainable Products Research & Development Department, Ebara Elliott Turbomachinery Corporation

Hiroto Hashimoto
R&D Section, Sustainable Products Research & Development Department, Ebara Elliott Turbomachinery Corporation

Business Strategies

Infrastructure Company

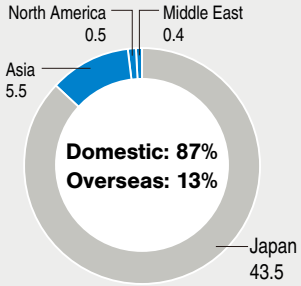
Business Vision (E-Vision 2030)

In the areas of water, air, and the environment, we are striving to make social and industrial infrastructure more efficient and resilient by innovating our products and services, and to realize a sustainable society where people around the world can live comfortable and abundant lifestyles.

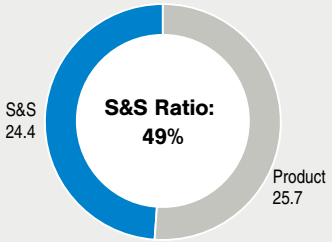
Company Information

Main Target Markets	• Water infrastructure
Main Products	• Custom pumps • Fans
Market Share and Main Achievements	• #1 domestic share in pumps for drainage pumping stations • Ebara pumps installed at more than 1,000 drainage pumping stations in Japan Note: Ebara survey
Production Bases	• EBARA CORPORATION, Futtsu Plant • Ebara Vietnam Pump Company Limited: Hai Duong Plant (Vietnam) • EBARA DENSAN: Yamaguchi Plant
Competitors	• Japan: Kubota Corporation, DMW Corporation, Torishima Pump Mfg. Co., Hitachi Industrial Products, among others • Overseas: Flowserve (US), KSB (Germany), Sulzer (Switzerland)

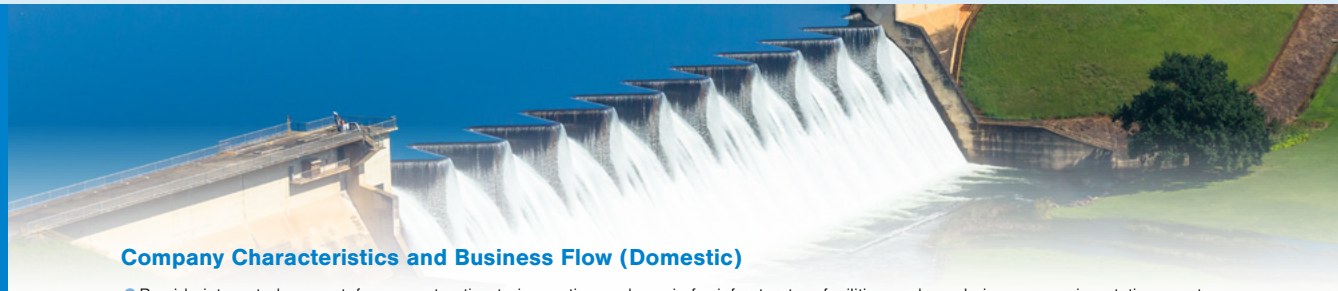
Revenue by Region (Billions of yen)



S&S Revenue Ratio (Billions of yen)

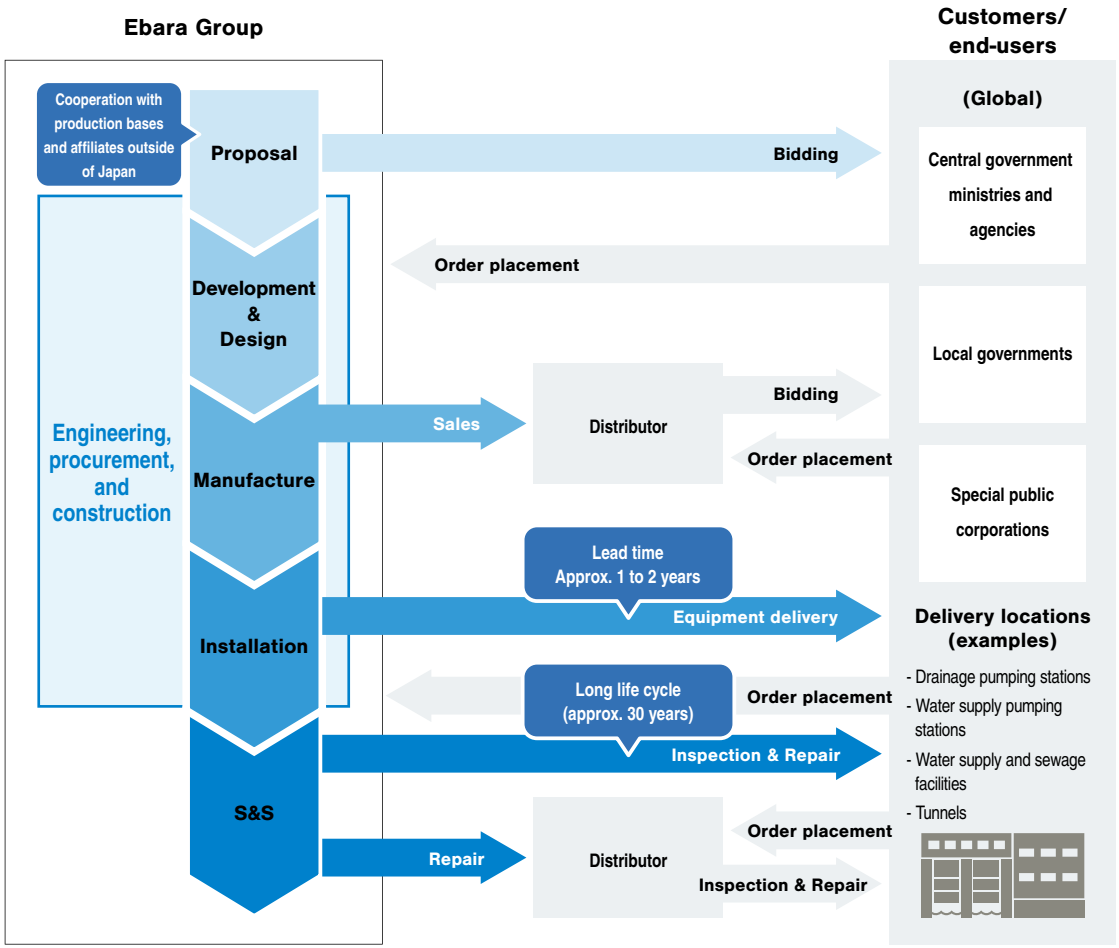


Note: The above graph displays actual figures for the fiscal year ended December 31, 2023.



Company Characteristics and Business Flow (Domestic)

- Provide integrated support, from construction to inspection and repair, for infrastructure facilities such as drainage pumping stations, water supply and sewage facilities, and tunnels
- Relatively long product life cycle



Infrastructure Company

We will continue to provide peace of mind and safety and contribute to a sustainable society.

The Infrastructure Company is the business Ebara was founded on, and it is directly involved in tackling social issues. As such, we are mindful of how we can provide solutions to global crises such as climate change and water scarcity.

A stable revenue base for the Group, the Infrastructure Company will steadily ensure profitability while maintaining a large share of the domestic market amidst increasing demand for reconstruction and maintenance of infrastructure. In order to rapidly implement these approaches, we will promote the digital transformation (DX) of production management and improve productivity. We have established a Business Innovation Promotion Department and are using the IoT to improve proposals for construction and maintenance management techniques. In addition, we will also spread production innovations to our sites in Asia, and China and Vietnam in particular, we will increase our competitiveness, and we will expand the scale of our business globally while ensuring profitability.

In addition, we value passing on Ebara's DNA to the next generation by focusing on the training of on-site engineers (qualified personnel) and human resources specializing in DX, and we are increasing our collaboration with stakeholders on a global level by accepting trainees from overseas and through partnerships with distributors.

With passion and dedication, we will sincerely face society and work to create a better future.

Teruyuki Ota

Executive Officer
President,
Infrastructure Company

Market Environment

Opportunities

- Increased demand for reconstruction and maintenance of aging social infrastructure in Japan
- Increased infrastructure investment in conjunction with rising water demand attributable to population growth and urbanization in East and Southeast Asia
- Accelerated infrastructure investment in North America
- Increased demand for disaster prevention and mitigation equipment for water-related disasters due to extreme weather

Threats

- Changes in the competitive environment in the domestic market
- Intensifying price competition in overseas markets
- Supply chain disruption due to world affairs

Our Strengths

- Extensive delivery track record (#1 share in Japanese public infrastructure pumps)
- One of Japan's leading service networks (Ebara bases and distributor network)
- Experience in construction and delivery of large-scale projects in Japan and overseas
- Large pump factory and testing facilities with world-class production technology

Basic Strategies of E-Plan 2025

1 Expand market share in the domestic pump market

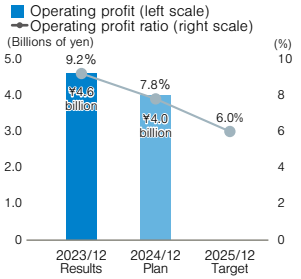
2 Deepen overseas pump market and secure profit

3 Improve productivity in and outside of Japan

In Japan, we seek to increase our share of the steady infrastructure market and increase revenue through enhanced product development capabilities to solve social issues and improvements in productivity. Outside of Japan, we identify growth markets and create new value using pumps, related equipment, and engineering technologies.

Financial Targets and Results

Operating Profit Ratio: 6.0% or higher



Non-financial Goals, KPIs, and Targets

Related Materiality	2025 Outcome Goals	KPIs	2025/12 Targets	2023/12 Results	Measures and Future Initiatives
1 Contribute to the creation of a sustainable society	Protect people's safe and secure lives from disasters through stable operation of pump equipment	Total drainage capacity of pumps delivered in the disaster prevention field (drainage volume per second)	145m³/s	Achieved 134% of target	- Expand share of pumps delivered in the domestic disaster prevention field - Deliver pumps in the overseas disaster prevention field using engineering technologies cultivated in Japan
	Reduce GHG emissions	Unit sales of products with low environmental impact	50	Continued product development	Develop and market high-efficiency pumps to reduce environmental impact and contribute to customer profits

Infrastructure Company

2023 Results and Future Challenges

Basic Strategies 1

Expand market share in the domestic pump market

Results

- Expanded our receipt of orders by continuing to focus on efforts such as comprehensively evaluated projects* and enhancing our distributors.
- Promoted in-house qualifications and mid-career hiring to increase the number of qualified on-site engineers.

* A form of bidding in which the successful bidder is determined by comprehensively evaluating price and factors other than price (e.g., quality).

Future Challenges

- Being actively involved in basin flood control led by the national government.
- Accelerating the search for new businesses by promoting product development from a market-driven perspective and aggressively promoting DX by newly established divisions.

Basic Strategies 2

Deepen overseas pump market and secure profit

Results

- Increased efforts to win projects in North America and the Middle East, which are markets where Ebara's (head office) technological advantage can be demonstrated.
- Established a system of support from headquarters to improve system technology mainly for affiliates in Southeast Asia.

Future Challenges

- Enhancing our foray into markets outside of Japan in cooperation with affiliates.

Basic Strategies 3

Improve productivity in and outside of Japan

Results

- Improved profitability through synergy among our divisions and other in-house companies to reduce procurement and other costs.
- Mindful of profit and loss at the Futtsu Plant on a non-consolidated basis, we worked to improve the product manufacturing cost ratio and to expand S&S business, and we increased profits.

Future Challenges

- Raising awareness of cost planning based on the ExValuE* project and expanding business while increasing profits.
- Promoting the restructuring of production lines and the DX of design and operational processes.

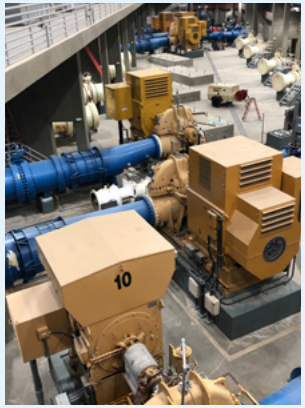
* This project is to promote a shift to pursuing maximizing customer value and profits for Ebara starting in the product planning stage (functional improvements, reduced costs, and timely market launches) in order to provide more value to our customers, as set forth in E-Vision 2030.

Value Creation 熱い設

Ebara Receives Order for Water Pumps for Las Vegas, Nevada

Helping to develop local infrastructure through global collaboration

The Southern Nevada Water Authority (SNWA) is the local government agency responsible for supplying water to and managing the water resources of the Greater Las Vegas Valley, supplying domestic water to more than two million people. To help meet the community's water needs, increase operational flexibility, and bolster the reliability of the water system, SNWA implemented a Major Construction and Capital plan in 2020 to develop infrastructure over the next 10 years. As part of the plan, a project to add a total of eight additional double-suction single-stage centrifugal pumps to two pumping stations in the area started in 2024. A joint team from Ebara and its US subsidiary received the order. The Group has delivered many large water pumps to the SNWA in the past, and they have received high marks. Ebara will continue to work together with the SNWA to develop future infrastructure for the region, in addition to promoting collaboration between the Head Office and Group companies worldwide to produce better results.



Interview

Delivering Ebara's reliable pumps around the world for the future

The sales team from the head office, the factory, and the Group company involved in the project worked diligently as a team to draft a proposal that would fully satisfy the customer in terms of technology and price. Ebara's reliable pumps have a proven track record, and we are very aware that the work of the past is connected to our present, and the work of the present will bring forth the future. With that ideal in mind and with passion and dedication, Ebara was able to secure the order with the customer in Nevada. Being able to contribute to the water infrastructure of an economically important city like Las Vegas, where approximately 70% of Nevada's population is concentrated, is highly significant for Ebara. We will continue to work closely with partners around the globe to contribute to local water infrastructure, not only with pumps for water supply but also with desalination plants and other projects.

Jie You
Global Sales Department, System Business Division

Nanae Nagamine
Ebara Pumps Americas Corporation

Business Strategies

Environmental Solutions Company

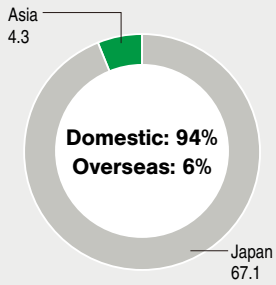
Business Vision (E-Vision 2030)

Expand business to become a resource circulation solutions provider with operations centered on waste treatment plant construction and operation that provides integrated EPC services primarily to local government.

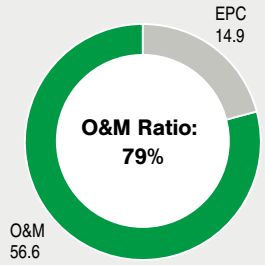
Company Information

Main Target Markets	• Solid waste treatment
Main Products	• Municipal waste incineration plants • Industrial waste incineration plants
Market Share and Main Achievements	• Over 500 domestic and overseas waste treatment facilities delivered cumulatively • Over 80 waste treatment plants under contracted operation & maintenance cumulatively Note: Ebara survey
Production Bases	EBARA QINGDAO (China): Design, manufacture and sales of incinerators, waste heat boilers, sludge dryers, auxiliary equipment, gas treatment facilities, etc.
Competitors	Hitachi Zosen (Japan), JFE Engineering (Japan), Takuma (Japan), Nippon Steel Engineering (Japan)

Revenue by Region (Billions of yen)



O&M Revenue Ratio (Billions of yen)

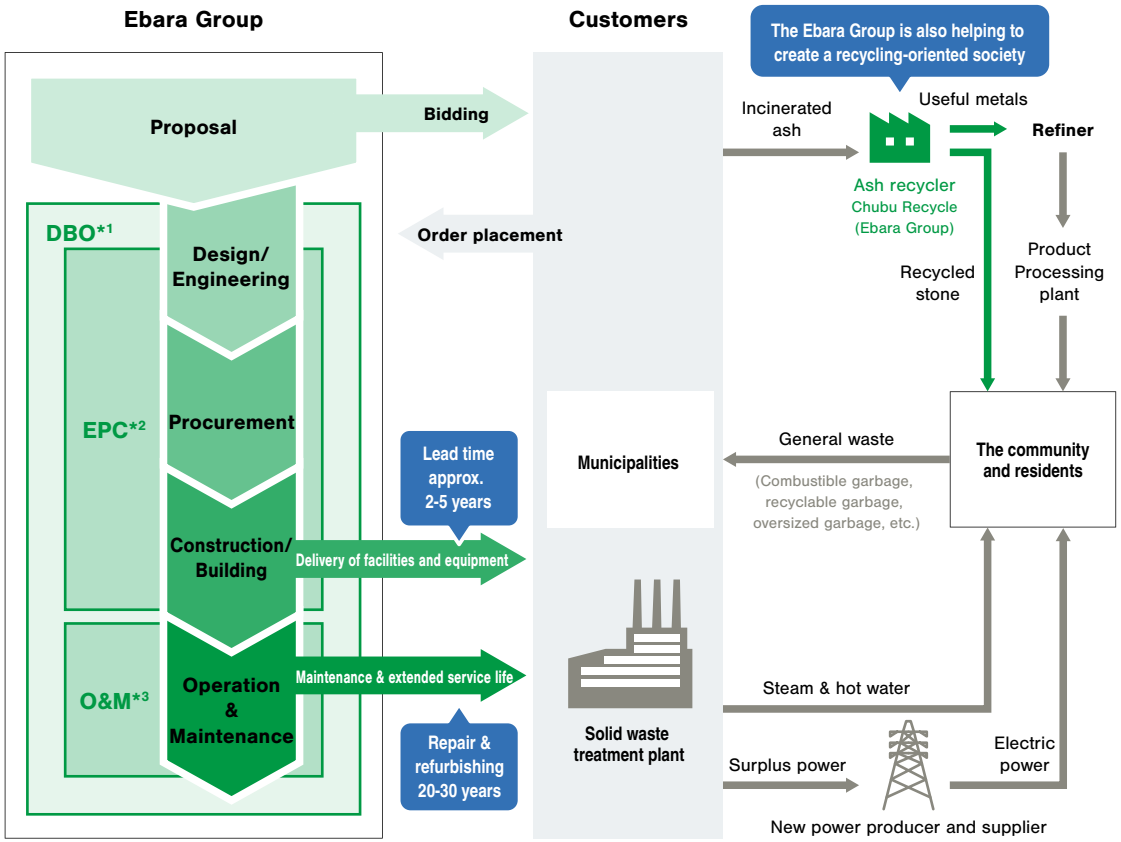


Note: The above graph displays actual figures for the fiscal year ended December 31, 2023.

Company Characteristics and Business Flow

- Three business models: DBO*1, EPC*2, and O&M*3
- DBO and O&M involve repair and refurbishing for 20 to 30 years
- Creating a mechanism to achieve a circular economy, including local production and local consumption of electricity through power generated by incinerating waste and reuse of metals from incinerator ash
- The Ebara Group also plays a part in the recycling of incinerator ash (Chubu Recycle).

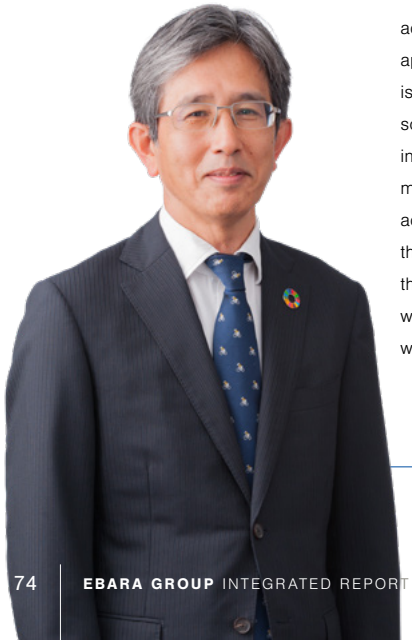
*1. DBO: An approach whereby the government (e.g., a public entity) procures financing and owns a facility while contracting a private operator to design, build, and operate the facility
*2. EPC: Engineering, procurement, and construction of a facility
*3. O&M: Services to operate and maintain a facility



Environmental Solutions Company

The Environmental Solutions Company will strengthen the basis for trust in it with its core business and grow into a recycling solution provider.

The slogan for the Environmental Solutions Company is "Change the thinking on disposal. Change the future." The Environmental Solutions Company is focused on becoming a recycling solution provider. Its core business is the construction and operation of solid waste treatment plants, and it is also involved in chemical and waste recycling. In order to achieve that vision, the earnings base for its core business has to be strengthened first. Assuming a labor shortage in the future, the Environmental Solutions Company will improve the quality and increase the value of asset management by proactively introducing AI/ICT and accelerating automation. The market is expected to shrink due to the progress of recycling and a decreasing population. In that market, we will strive to continue consistently receiving orders and ensure the volume of assets by focusing on preparatory efforts in the basic concept stage of projects and by further enhancing its ability to accurately discern customer needs and make proposals.



Recycling, decarbonization, and adoption of a nature-positive approach have become global issues. Over the past few years, society as a whole, including individuals, companies, and municipalities, has united to accelerate various efforts to address those issues. Our mission is to take the lead in helping to create a world where people can live in comfort with nature.

Hideki Yamada

Executive Officer
President, Environmental Solutions Company

Market Environment

Opportunities

- Reconstruction and upgrade demand from aging waste treatment plants
- Increased outsourcing of plant operation to the private sector
- Increased demand for renewable energy
- Need for waste plastic processing (enforcement of the Act on Promotion of Resource Circulation for Plastics)
- Trends to improve chemical recycling rate of waste plastic

Threats

- Consolidation of waste treatment plants in response to domestic population decrease
- Workforce contraction
- Intensification of price competition

Our Strengths

- Integrated system for providing services ranging from engineering and construction to O&M
- Track record of constructing more than 500 plants in Japan and overseas utilizing a wide range of incinerator technologies
- O&M expertise founded on industry-leading operation contracting track record
- Cutting-edge plant operation initiatives employing AI and ICT
- Gasification technologies related to chemical recycling

Basic Strategies of E-Plan 2025

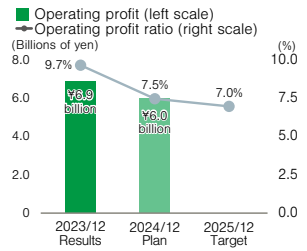
1 Bolster the foundation of our core business

2 Strengthen initiatives as a solution provider based on Life Cycle Assessment (LCA) by appropriately grasping changes in the market, such as decarbonization and resource recycling

The Environmental Solutions Company is striving to improve price competitiveness of new DBO projects and prevent additional EPC costs while working to further strengthen the revenue base for O&M projects. We are also strengthening relations with communities and municipalities and enhancing our forays into the market as a provider of decarbonization and recycling solutions revolving around LCA.

Financial Targets and Results

Operating Profit Ratio: 7.0% or higher



Non-financial Goals, KPIs, and Targets

Related Materiality	2025 Outcome Goals	KPIs	2025/12 Targets	2023/12 Results	Measures and Future Initiatives
1 Contribute to the creation of a sustainable society	Reduce GHG emissions	Number of new waste treatment facilities that generate thermal electricity from waste processing	3 facilities during the 3 years of E-Plan 2025	Cumulative total 1 project	- Construct waste treatment facilities that generate thermal electricity from waste processing - Introduce high-efficiency power generation equipment to further reduce GHG emissions
	Develop technologies that reduce CO_2 emissions and enable carbon resource circulation	Development of practical applications of technology (ICFG®*) for reusing chemical raw materials derived from waste plastics (implementation in 2030)	Implementation of pilot testing	Completed design of a pilot test facility	Constructed a pilot testing facility and conducted tests in order to improve the yield and quality of the technology for converting waste plastic into oil and to materialize a scheme with partner companies for the practical application of chemical recycling

* ICFG® is a registered trademark of Ebara Environmental Plant in Japan

Environmental Solutions Company

2023 Results and Future Challenges

Basic Strategies 1

Bolster the foundation of our core business

Results

- Extended service life, maintenance, and long-term comprehensive sales in O&M increased and contributed to profits.
- The profitability of the company's electricity sales business improved as a result of a review of new power production and supply contracts.

Future Challenges

- In order to enhance the company's ability to propose EPCs for public sector demand, the company has positioned proposals to contribute to local communities and generate power and reduce CO_2 as its most important efforts, and it will focus on proposing value-added solutions to achieve optimal facilities management while ascertaining the status of projects over the long term.
- Proposing hardware and software solutions to detect fires caused by lithium-ion batteries in garbage and to prevent the spread of fire, thus enhancing fire prevention at customer facilities.

Basic Strategies 2

Strengthen initiatives as a solution provider based on Life Cycle Assessment (LCA) by appropriately grasping changes in the market, such as decarbonization and resource recycling

- In order to respond to changes on the path to a circular economy and decarbonized society after 2030, the company is developing chemical recycling technology using internally circulating fluidized-bed gasification (ICFG®*). The company will start construction of a pilot test facility in 2024, and it intends to operate a commercial facility by 2030.
- The company intends to respond to the declining workforce in the operation of maintenance and management facilities by actively investing in automation and reduced labor requirements and it intends to reduce occupational accidents by reducing hazardous work.
- To combat global warming, the company intends to proactively propose carbon-neutral projects to extend service life in order to create a sustainable society.

* ICFG® is a registered trademark of Ebara Environmental Plant in Japan.

Value Creation 熱と設

Construction of the Tachikawa City Clean Center

(Official name: Project for the Construction and Operation of a New Waste Incineration Plant in the City of Tachikawa)

Looking after the safety of the community and the environment with technology

Ebara Environmental Plant received an order for a new project, a waste incineration plant, from the city of Tachikawa, Tokyo in 2019, and construction of the Tachikawa City Clean Center (TACHIMNey) was completed in 2023. The company will operate the plant for 20 years and 1 month.

We sought to create a facility that is environmentally friendly, safe, and efficient and that will function as a regional disaster prevention site in the event of a large-scale disaster. Steps have been taken to reduce the facility's environmental impact on its surroundings, and stringent voluntary emissions standards have been set. The surplus heat produced during waste treatment will be used by high-temperature and high-pressure boilers and highly efficient turbines to generate electricity. In addition, the facility is equipped and structured to be able to operate even in the event of a large-scale disaster by ensuring that it is highly water- and earthquake-resistant. The facility will contribute to the sustainable development of the community through stable operation as a disaster prevention site.

Interview

Seeking to be a beloved facility that is close to the community

This Clean Center will provide a variety of added value by creating a sanitary environment, reducing CO_2 emissions by generating power from waste incineration, and by having the ability to teach local children about the environment. The project team worked together to construct the facility in the hopes that it will be a long-beloved facility in the community.

Incorporating numerous requests to improve the facility from both inside and outside the company in the design was a very difficult job, but it was also very rewarding, and the team was thrilled to receive words of appreciation from the customer upon completion. The Clean Center will strive to contribute to the local community through operations over the long term and serve as a symbol of recycling.

Masamitsu Sase
Ebara Environmental Plant

Business Strategies

Precision Machinery Company

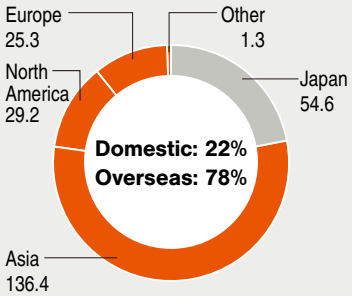
Business Vision (E-Vision 2030)

Contribute to the development of society through partnerships and distinctive technologies centered on the semiconductor field while helping create a more enriched world through endeavors in new fields.

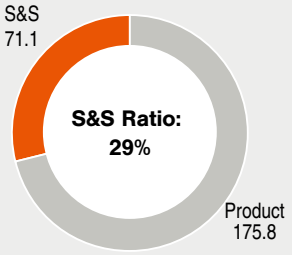
Company Information

Main Target Markets	• Semiconductor manufacturing
Main Products	• Dry vacuum pumps • CMP systems • Gas abatement systems
Market Share and Main Achievements	• #2 global share in CMP systems • #2 global share in dry vacuum pumps Note: Ebara survey
Production Bases	Fujisawa Plant, Kumamoto Plant
Competitors	• Dry vacuum pumps: Atlas Copco (Edwards Vacuum) (UK), Kashiyama Industries (Japan) • CMP systems: Applied Materials (US)

Revenue by Region (Billions of yen)



S&S Revenue Ratio (Billions of yen)

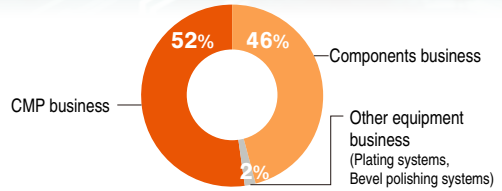


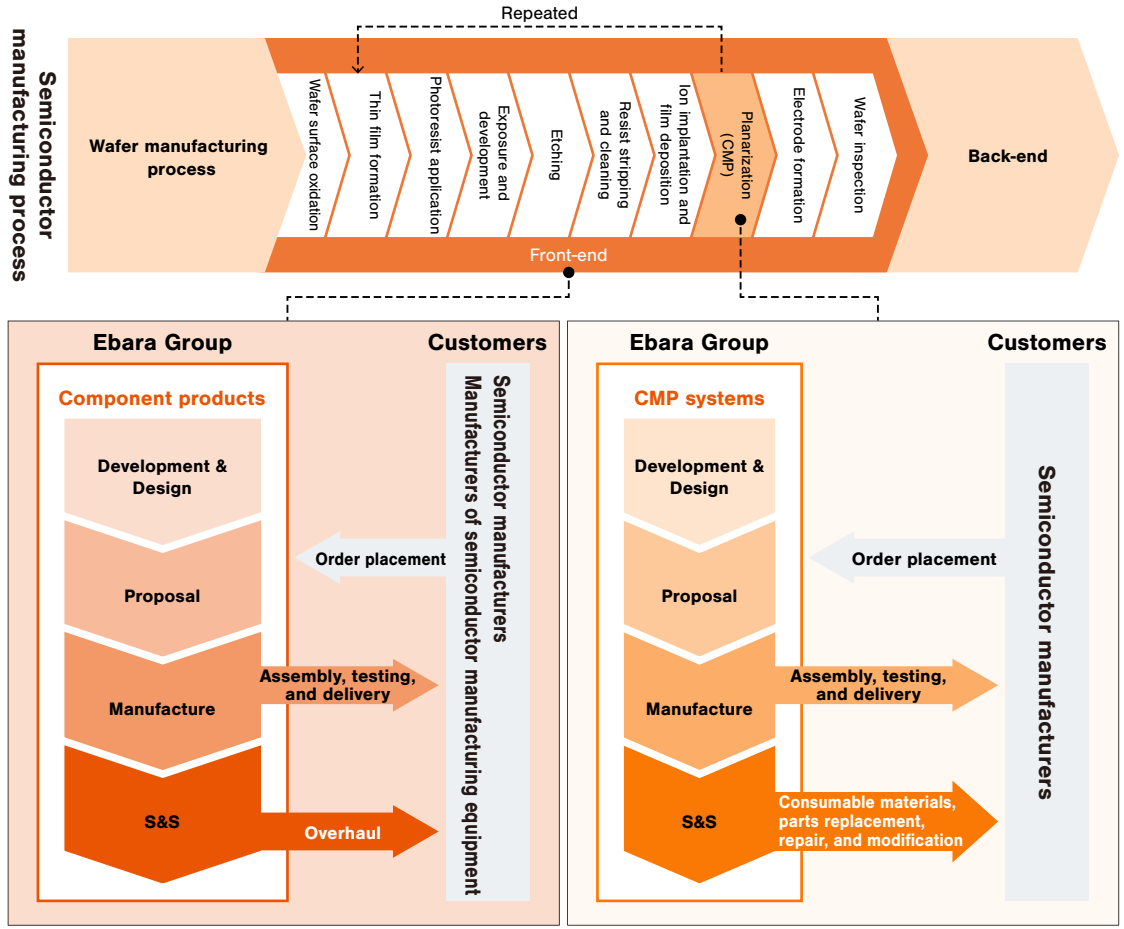
Note: The above graph displays actual figures for the fiscal year ended December 31, 2023.

Company Characteristics and Business Flow

- Component products such as dry vacuum pumps and gas abatement systems used in the entire front-end process of semiconductor manufacturing are supplied to semiconductor manufacturers and manufacturers of semiconductor production equipment
- Chemical mechanical polishing (CMP) systems used in the planarization process (a front-end process) are delivered to semiconductor manufacturers

Proportion of Revenue by Business





Precision Machinery Company

We lead the advancement of the semiconductor industry with the world's highest level of technology and support.

As a result of the expanded use of digital technology for ICAC5*, DX, and GX, semiconductors have become an essential technology for industry and society as well as an important technology in terms of security. In addition, the structure of semiconductor devices is predicted to rapidly advance with further miniaturization and adoption of a three-dimensional architecture. We believe that our mission is to shape the advancement of semiconductor manufacturing processes along with our customers. We have been working on R&D themes from a medium- to long-term perspective and enhancing the structure of our business with an eye toward market growth.

As the semiconductor device manufacturing process transitions from using nanometers (nm) to angstroms (Å) as the standard unit (1Å = 0.1 nm), our Equipment Business is intensifying its R&D efforts, including through joint development projects with customers and academic institutions. A new R&D building that is currently under construction will be completed next year, and we will work on developing even more new products and next-generation processes, contributing to the advancement of the angstrom generation of semiconductors.

The Component Business will focus on providing products and solutions that meet the needs of our customers, such as taking up less space, reduced power consumption, and reduced CO_2 emissions, with optimal exhaust systems combining dry vacuum pumps and gas abatement systems in the sub-fab. We will also increase our production capacity globally.

We will help to advance the semiconductor industry by providing our customers with the world's highest level of technology and support, and we will do our utmost to contribute to a future where dreams come true.

* An acronym for the IoT, the cloud, AI, self-driving cars, and 5G

Isao Nambu
Executive Officer, Co-COO, Equipment Business & Sales & Management Strategy, Precision Machinery Company

Seiichi Tsuyuki
Executive Officer, Co-COO, Component Business & Advanced Technology, Precision Machinery Company

Market Environment

Opportunities

- Increased demand for semiconductors due to the spread of the IoT, AI, and self-driving cars, the diversification of working patterns using cloud computing and communications, the spread of DX and the Metaverse, and expanded investment in green transformation
- International strategic management of semiconductor resources and attendant active investment in the area of semiconductors in China, Europe, the US, and other regions
- Demand for new equipment due to the creation of new semiconductor manufacturing techniques as a result of the advancement of (highly integrated) semiconductors

Threats

- A wave of capital investment due to fluctuations in semiconductor demand
- Changes in market trends due to geopolitical risks and their impact on production systems and customer support
- Rising energy costs leading to price increases
- Stricter environmental regulations on PFAS and other substances and their impact on semiconductor manufacturing
- Attracting human resources in a rapidly expanding semiconductor market

Our Strengths

- Rotating machinery, fluid equipment, machine control systems, gas decomposition and abatement, and energy conservation technologies
- Advanced production technology capabilities such as automated production with robots
- Bases positioned near customers worldwide
- Flexible, high-quality customer support capabilities
- Amassing and passing on technology by retaining human resources
- Sending highly skilled personnel around the world

Basic Strategies of E-Plan 2025

1 Strengthen product and solution development capabilities

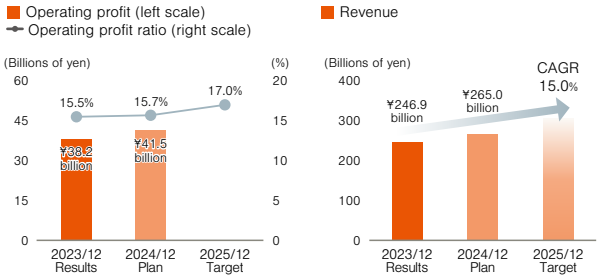
2 Increase production capacity

3 Reconstruct global business infrastructure to accommodate expansion of business scale

We intend to move away from a product-oriented model of providing products and services to a model of providing new value that only Ebara can offer, starting with the customer's problems. In addition, we will rapidly strengthen our structures in anticipation of our customers' production expansion and global development, and support the rapid growth of the semiconductor market to drive our own business expansion.

Financial Targets and Results

Operating Profit Ratio: 17.0% or higher Revenue CAGR: 15.0% or higher



Non-Financial Goals, KPIs, and Targets

Related Materiality	2025 Outcome Goals	KPIs	2025/12 Targets	2023/12 Results	Measures and Future Initiatives
1, 2	Reduce GHG emissions	Amount of GHG emissions that can be reduced by gas abatement systems in semiconductor manufacturing processes that use GHGs	20% increase from 2022	5.6% increase compared to 2022	Developing gas abatement systems that do not use fossil fuels
		Reduction of GHG emissions from dry vacuum pump manufacturing	10% reduction from 2022	5.1% increase compared to 2022	Reducing environmental impact through a lighter weight
	Reduce water usage and discharge	Reduction of pure water use by CMP systems	30% reduction from 2022	Development in progress	Developing cleaning methods that consume less pure water
	Develop foundational technologies for semiconductor miniaturization	Development of foundational technology for 14Å semiconductor manufacturing	100%	55%	Promoting the development of constituent technologies for CMP to support technology for the manufacture of the 14Å generation of semiconductors

Precision Machinery Company

2023 Results and Future Challenges

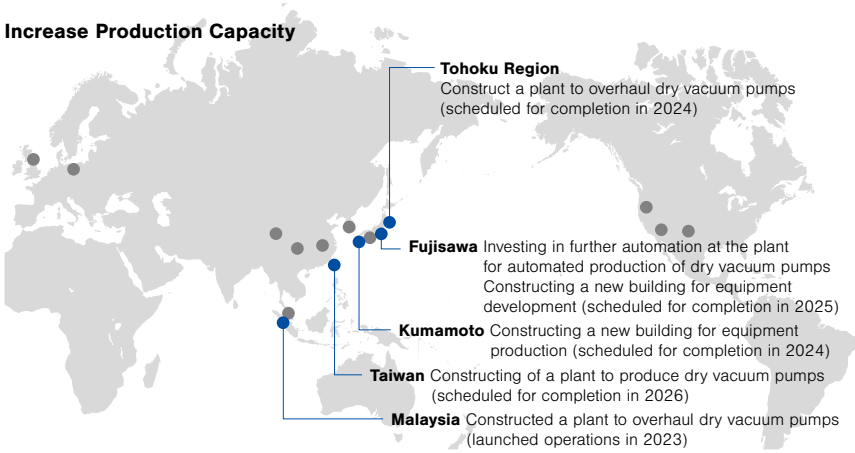
Results

- The semiconductor market is in an adjustment phase, but we achieved record revenue and operating profit.
- We are promoting the following investments to enhance production, procurement, and support systems:
  - · Established a new site in Malaysia, including a plant for the overhaul of dry vacuum pumps.
  - · Began construction of a plant for the overhaul of dry vacuum pumps in Tohoku region.
  - · Decided to build a second plant to produce dry vacuum pumps in Taiwan.
  - · Began construction of a new building for equipment production in the Kumamoto Plant.
  - · Began construction of a new building for equipment development in the Fujisawa Plant.

Future Challenges

- Accelerating investment in expanded production and acquisition of human resources for future growth.
- Enhancing the development structure for new solutions.
- Further enhancing our globally consolidated system and improving the management infrastructure by introducing ERP at sites in Japan and overseas.

Increase Production Capacity



Topic

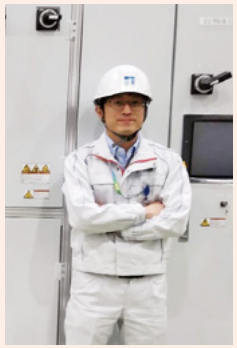
Contributing to Advanced Semiconductors

Along with our partners, we are developing constituent technologies for CMP and process solutions to support technology for the manufacture of the 14Å generation of semiconductors. By overcoming many challenges, such as responding to the introduction of new materials as semiconductors advance and requirements for new levels of planarization performance, and improving performance with respect to defects (scratches, dust, corrosion, etc.), we have enabled the creation of semiconductors with more integrated capabilities. We will work to further innovate technology in order to lead the way in semiconductor miniaturization, layering, and integration.

Value Creation 熱い設

A vacuum exhaust system for EUV lithography equipment

Advances in state-of-the-art microfabrication technology and reduced environmental impact



The use of EUV lithography equipment for circuit patterning in semiconductor manufacturing processes is expanding as miniaturization advances. EUV lithography is a technology in which extreme ultraviolet (EUV) light produced by a light source is reflected by lenses and is delivered to a photomask with a circuit pattern on it, where it is transferred onto the wafer like an outline. A vacuum has to be created inside the equipment to ensure that EUV light is not absorbed.

This process uses a large volume of hydrogen. We have developed a product that provides both a vacuum and gas abatement at high levels, and it is being used by major semiconductor manufacturers. As lithography equipment has advanced, the volume of hydrogen used has increased and gas abatement systems have increased in size. However, we have developed a new gas abatement system that consumes less power while reducing the footprint compared to our conventional systems.

Interview

Supporting our customers with gas abatement technology and combined strength

Reducing the footprint and energy consumption in our customers' factories is a significant challenge, one that becomes even more crucial with the reliance on EUV lithography equipment for advanced semiconductor manufacturing processes. As a provider of total solutions in gas abatement, we leverage our technological expertise and combined strengths to support EUV lithography while minimizing its environmental impact. In order to make the system even more environmentally friendly in the future, we are working to develop products that reuse hydrogen.

Technological advances in semiconductor manufacturing are what make an affluent lifestyle possible. These advances are occurring at an ever-increasing pace. By collaborating with and engaging in dialogue with our engineers and sales staff in Japan and overseas, we hope to make our customers' development roadmaps a reality and propose solutions that anticipate future needs.

Yu Segawa
System Development Section, Vacuum Product Engineering Department, Component Division

New Businesses

New Value Creation

We will actively engage in internal and external collaboration and joint development, promote the visual depiction of the Ebara Group's technologies and human resources, and steadily work to develop our business while forming business alliances with other companies.

Ebara's human resources and technologies

Map of Technological and Organizational Capabilities × Strategic Table of Technological Capabilities P35

Internal and external collaboration

Products, technologies, and solutions owned by other companies

• Energy transition • Recycle plastic waste as a resource	Hydrogen	• Liquid hydrogen transportation, turquoise hydrogen Construction of hydrogen supply chain • Chemical recycling Re-source waste plastics to petroleum and chemical feedstock
• Increasing demand for commercial rockets	Aerospace	• Rocket/aircraft engine fuel feeding pumps Support the growth of the commercial rocket market and hydrogen aircraft market for satellite applications
• Increased demand for marine resources • Seawater pollution • Biodiversity	Marine	• Land-based aquaculture
• Development of biotechnology	Bio	• Structural protein materials • Regenerative medicine • Cultured cell meat
• Global warming	GX*	• Next-generation energy
• Water shortage • Food shortage	Life	• Water supply • Smart farms

* GX: Green Transformation

Hydrogen

Creating a unique hydrogen business to "make, transport, and use" hydrogen to achieve carbon neutrality by 2050

Many countries around the world have issued declarations on achieving carbon neutrality, resulting in an irreversible move toward decarbonization. In Japan, revision of the Basic Energy Plan and promotion of the National Strategy for a Green Transformation are accelerating toward the target for 2030 and net zero by 2050. Moves toward decarbonization are gaining momentum in many parts of the world, including about 50 trillion yen in national support in the US and about 140 trillion yen in public and private investment in Europe.

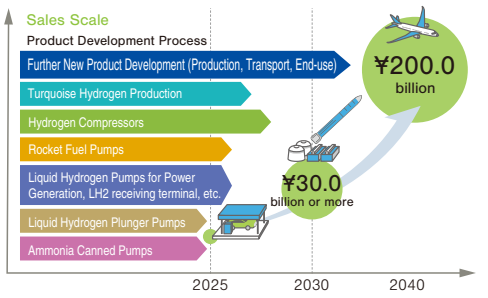
In the areas of making, transporting and using hydrogen, global demand for resources like hydrogen is expected to increase more than five-fold by 2050. Technologies are being developed and businesses are being created to contribute to various areas, including mobility, power generation, and industry. The Ebara Group is striving to implement technologies related to clean hydrogen in every area of "mak[ing], transport[ing], and us[ing]" hydrogen in order to help create a hydrogen energy-based society for the future.

In terms of "mak[ing]" hydrogen, we are developing and marketing hydrogen produced by gasifying waste plastics and other forms of waste and turquoise hydrogen that is produced by separating hydrogen and carbon from methane. In terms of "transport[ing]" hydrogen, we are developing and marketing liquid hydrogen pumps and leak-free liquid ammonia pumps that are essential for large-scale supply chains as well as cryogenic hydrogen gas blowers and hydrogen compressors. We are developing total products for both land-based and marine transport applications to ensure that supply chains are uninterrupted.

In terms of "us[ing]" hydrogen, we are working on products in wide-ranging parts of the hydrogen market such as power generation, industry, mobility, and the construction industry. These products include systems to boost and supply liquid hydrogen to hydrogen fueling stations, hydrogen-powered absorption chillers, and fuel supply pumps for hydrogen-powered aircraft in the future.

We are creating the society of the future and trailblazing new roles for Ebara to take on.

Business Scale Growth



	Helpful	Harmful
Internal origin	**Strengths** • World-class core technologies such as compressors and cryogenic pumps • Synergies with our five in-house companies • Sales network in Japan and around the world • Companywide momentum for fostering new businesses	**Weaknesses** • Lack of human resources who can take on the challenge of new businesses
External origin	**Opportunities** • Japan: Revision of the Basic Energy Plan and implementation of the Act to Promote GX • US: 50 trillion yen in support via the Inflation Reduction Act (IRA) • Europe: The EU's Green Deal Industrial Plan (issued in February 2023) • Promoting the system to subsidize commercial hydrogen and ammonia supply chains to create a market for clean hydrogen • Determination of subsidies to different countries to encourage the spread of hydrogen energy	**Threats** • Global conflict that leads to slowed decarbonization momentum • Delayed development of hydrogen-related technology

Ebara's Contribution to Hydrogen Supply Chain

Transport

Connecting the global hydrogen supply chain with liquid hydrogen pumps

Once liquid hydrogen that has been brought to Japan by sea is stored in domestic storage tanks, a booster pump is required to dispense it from the tanks to supply hydrogen gas turbines or to transfer it to hydrogen gas consumers nearby. Based on our strengths in high-pressure centrifugal pumps and cryogenic technology, we developed the world's first pump to supply liquid hydrogen as fuel in 2022, and it is ready for market launch.

Liquid hydrogen pumps

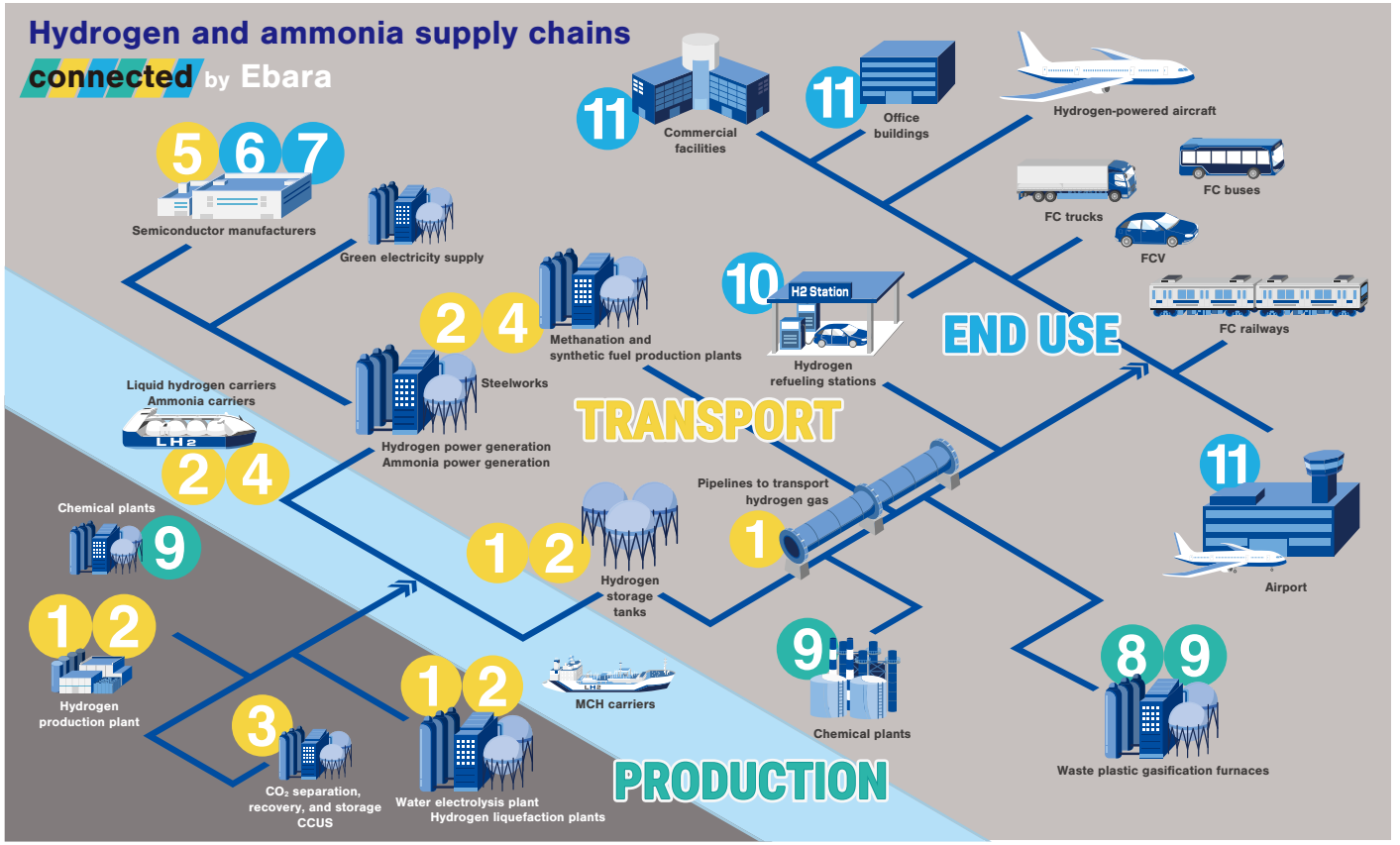
End Use

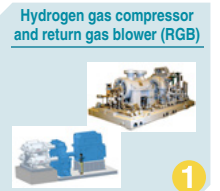
Development of liquid hydrogen plunger pumps to help spread large-scale hydrogen fueling stations for commercial vehicles

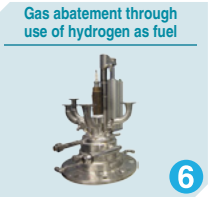
Filling commercial vehicles such as buses and trucks at large-scale hydrogen fueling stations requires faster filling to compensate for larger onboard tanks. In 2024, we are conducting tests with actual liquid hydrogen to evaluate pump performance. The development and commercial production of liquid hydrogen plunger pumps to continuously operate fueling stations and to reduce boil-off gas (BOG*) generation will help to reduce the future operating costs of hydrogen fueling stations.

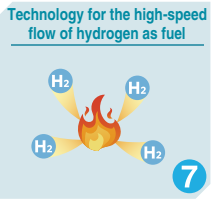
* Gas vaporized by natural heat transfer from outside the storage tank

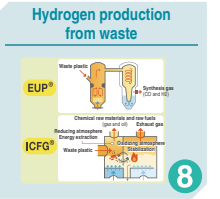
Liquid hydrogen plunger pump

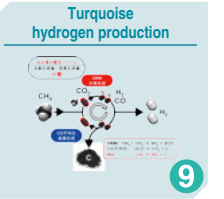


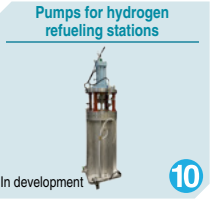












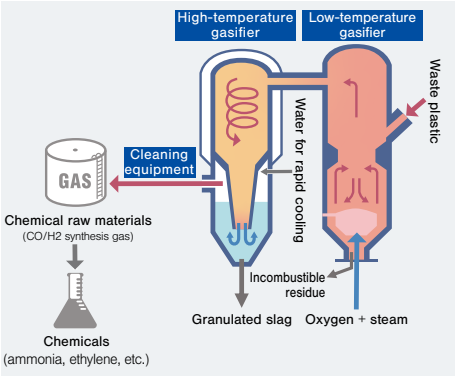
Ebara's Contribution to Hydrogen Supply Chain

Production

Ebara's chemical recycling technology enables hydrogen production from waste

Synthesis gas obtained via the EUP®* (hydrogen gas from waste plastic) is utilized as a raw material for ammonia production. Ammonia has conventionally been produced from fossil fuels such as naphtha, LNG, and coal, but we are instead utilizing hydrogen derived from waste plastic to help reduce fossil fuel use.

* This is a chemical recycling technology that gasifies high-calorie waste such as plastic at a high temperature and pressure, and we are the world's only company with a long track record of commercially operating a chemical recycling facility. EUP® is a registered trademark of UBE Corporation and Ebara Environmental Plant.



Conceptual diagram of the EUP®

End Use

Developed the world's first absorption chiller/heater powered by hydrogen (a hydrogen-powered absorption chiller/heater)

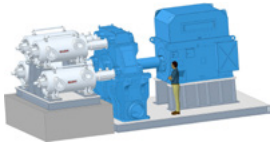
Conventional absorption chillers/heaters are powered with town gas or kerosene, but the product we developed in 2023 is powered with hydrogen, which enables fuel combustion without emitting CO_2. Compared to conventional fuels, hydrogen can reduce CO_2 emissions by 95% compared to kerosene and 94% compared to town gas on an annual basis. The chiller/heater also has the ability to "use" hydrogen by directly burning it instead of converting it into power or electricity. In 2024, we will use hydrogen gas to verify the operation of heating and air conditioning using hydrogen at facilities in Japan. Evaluating quality and performance during long-term operation with an actual load will enable us to further improve the reliability of our products and contribute to the "use" of hydrogen.

Hydrogen-powered absorption chiller/heater
View of the exterior of the RHDH* model
* Refers to the Ebara model number

Transport

Providing solutions that contribute to a society using new energy sources by transporting and boosting hydrogen gas

Two to four compressors can be individually operated and stopped, the operator can switch between operation in series or in parallel, and each compressor can be operated at various speeds. This approach also ensures against the risk of oil contamination even in applications that involve the handling of highly pure hydrogen. These compressors are suitable for hydrogen compression as well as for applications such as energy storage, processing, petroleum refining, and petrochemical production.



Flex-Op* hydrogen compressor

*Flex-Op™ is a trademark of Elliott Company in the US

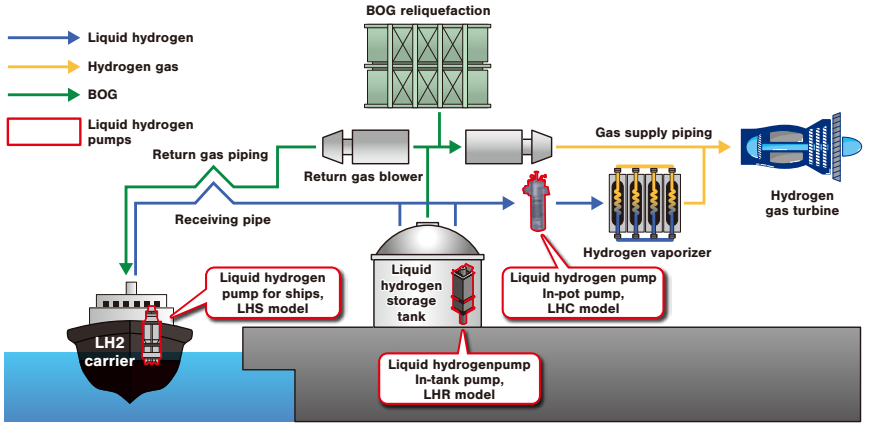
Technological Progress in the Area of Hydrogen Carriers (Liquid Hydrogen and Liquid Ammonia)

Demand for liquid hydrogen and liquid ammonia applications will continue to grow in order to reduce greenhouse gas (CO_2) emissions from thermal power plants. The Group intends to advance transfer technology in the areas of liquid hydrogen and liquid ammonia by drawing on its expertise in rotating machinery technology that it has developed over many years. Thus, the Group will help to construct the infrastructure for a hydrogen-based society in the future.

(Note) The following image is an example of the use of our rotating machinery technology with hydrogen.

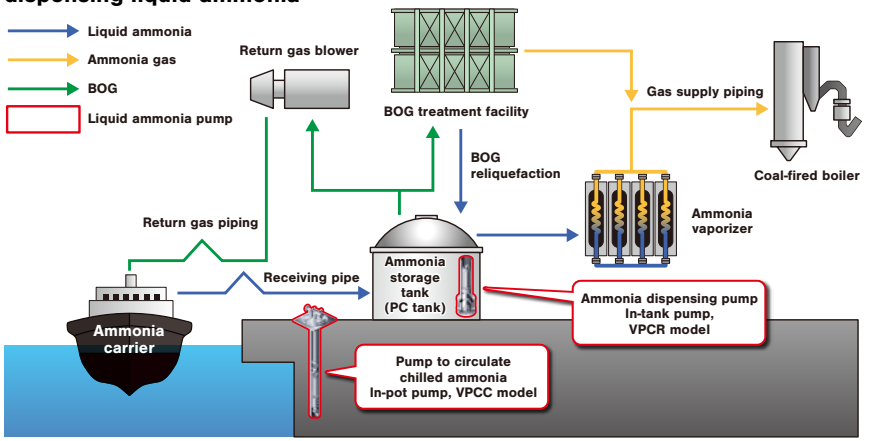
Transport

Pump for liquid hydrogen Flow chart for receiving, storing, and dispensing liquid hydrogen



Transport

Pump for liquid ammonia Flow chart for receiving, storing, and dispensing liquid ammonia



→ P69 Energy Company

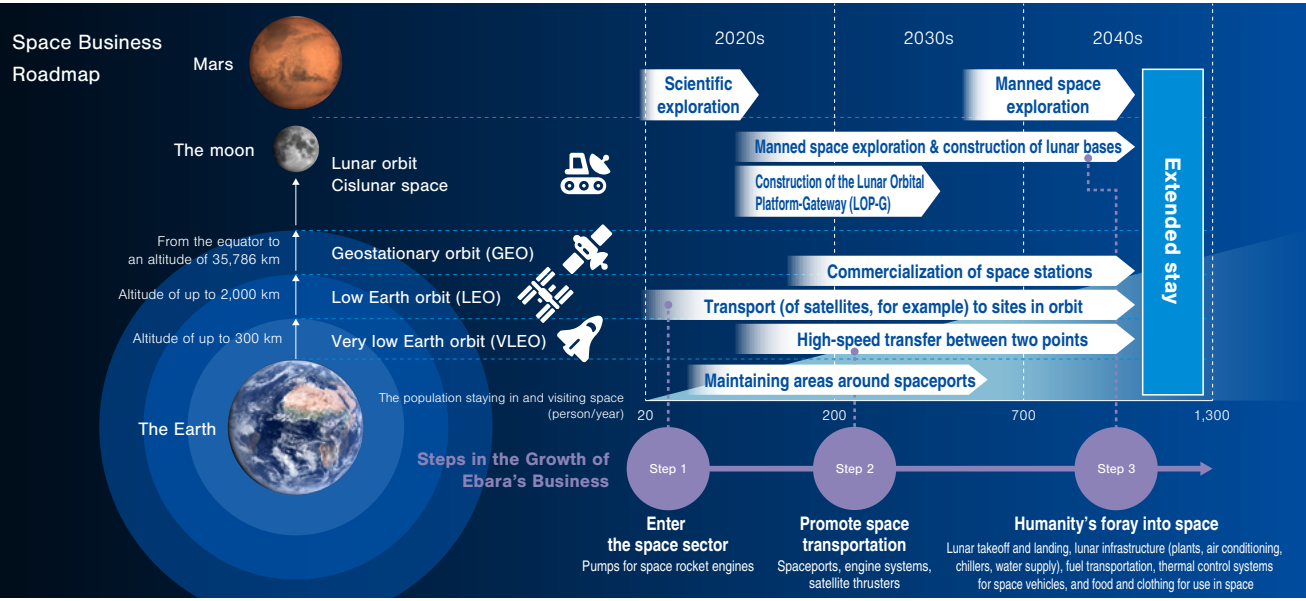
Aerospace

Creating technologies that provide new value and providing essential assistance for human activities in space

Since mankind's first foray into space, that unique environment has been capitalized on in a wide range of fields, including science, medicine, logistics, fisheries, agriculture, and communications. Over the past few years, the use of space by ground-based industries has accelerated, starting with the placement of a constellation* of small satellites in low Earth orbit, and the ways in which space is used have begun to evolve.

We believe that the Ebara Group can contribute to scientific advances and to global environmental conservation through developing for the next frontier of humanity, space exploration. However, lack of means of transport is a bottleneck to market expansion. Thus, we will first help to devise a means of transport that is inexpensive and highly flexible, increasing the limited number of gateways to space. To lower the cost of means of transport, we will draw on our rotating machinery technology that we have amassed for more than a century and our experience since the early 2000s in providing technical support to improve turbo pumps for rocket engines.

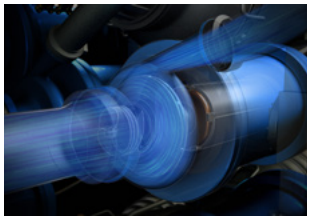
* A system in which multiple satellites are linked and operated together



Progress in 2023

1 Development of an Electric Pump for Space Rocket Engines

The pump we are developing for a space rocket engine is an electric pump that uses an electric motor to boost the pressure of liquid methane and liquid oxygen. It has been designed according to specifications for a two-stage rocket system with a maximum payload of 100 kg.



Electric engine pump concept

In 2023, we manufactured a tester for a pump for liquid methane according to those design specifications. After checking its assembly, we conducted a water test in a test facility at our Fujisawa Plant in December 2023, and we confirmed that it performed satisfactorily. In 2024, we are preparing for a liquid nitrogen test at the Japan Aerospace Exploration Agency's (JAXA) Kakuda Space Center. Testing is expected to be completed in the fall of 2024.

2 Joint Research with JAXA to Study the Feasibility of Electrically Operating Turbo Pumps for Rocket Engines

Since the 2000s, we have used our rotating machinery technology to assist JAXA in developing turbo pumps for rocket engines. Since 2018, we have provided technical cooperation in relation to studying the feasibility of electric pumps for rocket engines, and we are developing and testing electric pumps for practical use.

Electric pump tester
(at JAXA Kakuda Space Center)

In March 2023, a performance test of a tester manufactured through joint research was conducted at a test site at the JAXA Kakuda Space Center using liquid nitrogen, which stood in for fuel, as the working fluid. We confirmed that the electric pump reached the target speed of rotation and that the rotational speed control, which is unique to electric pumps, was operating normally.

3 Our Research Proposal for JAXA's Space Exploration Innovation Hub was Tentatively Accepted

In February 2023, JAXA's Space Exploration Innovation Hub issued a call for research proposals, and our research topic of "Electric centrifugal pumps that can pressurize highly corrosive fluids without external leakage" was accepted. This is a joint research project with JAXA and Mitsubishi Heavy Industries to develop a canned motor pump for high-speed rotation. The research was initially scheduled to take place until the end of March 2024, but it has been extended to September 2024 as a result of additional aspects to study.

Future Actions

Our Group has been developing products and engaging in business in line with the vision of creating technologies that provide new value and providing essential assistance for human activities in space. In response to the growing space market, we will continue our efforts in 2024.

Marine

Land-based Aquaculture

Providing a one-stop shop for "Production, Cultivation, and Delivery" as are required to engage in land-based aquaculture on an industrial basis

We are leading land-based aquaculture on an industrial basis by providing services with the entire value chain in mind, from the manufacture of aquaculture facilities to breeding assistance and the supply of feed and seed and the creation of sales systems. By producing high value-added land-farmed fish with a thorough commitment to taste and quality, we will help to solve issues in the fisheries industry.

Progress in 2023

1 Started Land-based Aquaculture of Whiteleg Shrimp for a Verification Test on a Commercial Scale

We are currently conducting trial breeding of whiteleg shrimp using a recirculating aquaculture system (RAS) that involves technologies such as fluid and thermal control. Plans are to begin a verification test on a commercial scale at a large aquaculture farm in Japan by the end of 2024. We are focusing on marketing activities, including the creation of a Japanese dish called Ebi Okowa (shrimp steamed sticky rice) using the white leg shrimp, which we then sold to a major department store's buyers' club.

2 Accelerated Partnerships

In the field of smart aquaculture (aquaculture environmental management using ICT), we are working to use our fluid and heat technologies to create recirculating land-based aquaculture systems and to devise services. By maximizing the value we provide in combination with the technologies of our business partners, we aim to create a world where people can continue to eat delicious fish in a sustainable manner.

Future Actions

- Advancing commercial production technologies through automated breeding systems using AI
- Collaborating with companies in various areas to provide a one-stop shop

Bio

Solutions for Cellular Agriculture

Helping to create a sustainable society by using fluid and thermal control technologies to develop culturing systems to meet customer needs

The field of cellular agriculture, which includes cultured meat, is garnering attention as a food technology to solve the food crisis caused by the increasing population of the world and climate change. In addition, structural proteins produced by fermentation are expected to be used as a new material that does not depend on conventional petroleum products. Both involve culturing, which is a process requiring the control of fluids such as culture medium containing nutrients and gasses such as oxygen and carbon dioxide as well as the control of temperature. Ebara's engineering expertise, developed since the company's founding, will help to create highly efficient and quality culturing.

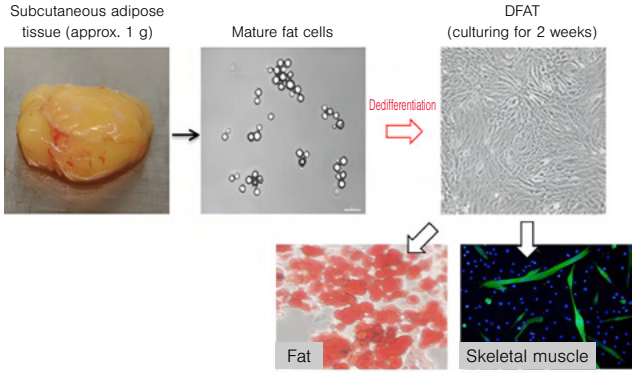
Progress in 2023

1 Started Joint Research with IntegriCulture

IntegriCulture Inc. is a startup that is developing cell culture technology. Its proprietary culture technology, the CulNet® System, can produce large volumes of culture medium for use in cell proliferation at a low cost. This technology is expected to be used in a wide range of applications, including cultured meat. In June 2023, we started joint research to supply a large volume of culture medium and to reduce its cost. We are working to expand the scale of and refine this technology using our fluid control technology and equipment design know-how.

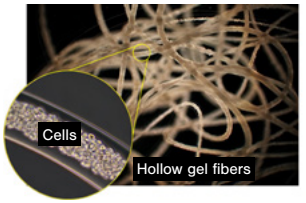
2 Started Joint Research with Nihon University

In June 2023, we began joint research on dedifferentiated adipose tissue (DFAT) cells with Nihon University. DFAT is a technology that can use discarded adipose tissue to produce cells such as muscle for use as the raw materials for cultured meat. We will create seed cells suitable for cultured meat and achieve mass culture and a lower cost.



3 Accelerated Joint R&D with CellFiber

CellFiber Co.,Ltd. is a startup that is developing cell mass production technology. The company has technology to mass culture quality cells at a high density using a special cell encapsulation technology known as CellFiber™. In 2021, we began joint R&D of a cell encapsulation system, and we are working to improve the production volume and achieve consistent quality by combining the system with an automated culture system.



Future Actions

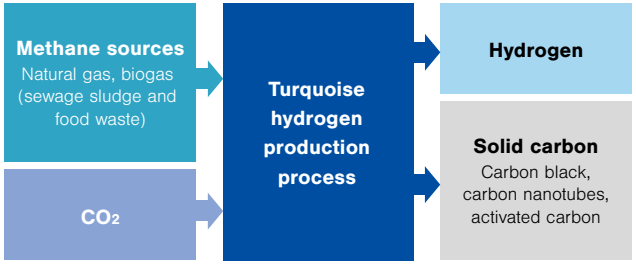
- Creating manufacturing systems and exploring sales channels for each technology
- Enhancing collaboration with partners and accelerating technological exchanges
- Focusing on recruiting biotech human resources

Green Transformation (GX)

Next-generation Energy

Establishing a process to produce turquoise hydrogen from methane and achieving efficient CCUS

We are promoting the development of a hydrogen and carbon production system utilizing reaction field separation (turquoise hydrogen production technology). This technology is contributing to efficient carbon capture, utilization, and storage (CCUS) by using a cyclical process to convert a hydrocarbon with high global warming potential (methane) into solid carbon for effective use. This process continuously carries out methane dry reforming, hydrogen separation, and carbon capture enabling hydrogen production without generating carbon dioxide.



Progress in 2023

1 NEDO Decided to Continue Research on Development of Innovative Hydrogen Production & Utilization Technologies

We have been conducting R&D on this topic since 2021. In May 2023, the decision was made to continue the research as a NEDO project in collaboration with the National Institute for Materials Science (NIMS), Kochi University of Technology, and Tokyo Institute of Technology ("Hydrogen production from methane via gas circulation and carbon dioxide recovery"). Through this project, we aim to implement these processes in society while seeking out new collaborative partnerships.

Future Actions

- Developing catalysts and circulation processes and expanding the scale of those processes
- Starting verification and feasibility studies with companies and local governments

Life

Water Supply

Ebara's specific contribution to society by delivering water to Africa, where population growth is accelerating

Water shortages are a global problem due to population growth and climate change. We are working to develop a business model for sustainable water supply that meets the needs of different countries.

Progress in 2023

1 Development of Water Supply Business in Africa

In 2021, the Ebara Group entered into a sponsorship agreement to support the drinking water supply business in Kenya through WaterKiosk®, developed by Boreal Light, a German start-up. We are providing safe, clean drinking water to communities such as schools by installing water purification units that use Ebara Group pumps. And in 2022, we established a site in Kenya. We are working to expand our business in Africa and to assist with agricultural development by improving irrigation. We will continue to collaborate with partners and promote business development in order to help solve the issue of a consistent water supply throughout Africa.

Future Actions

- Allocating investments and resources to regions with growth potential in order to create a business that will provide a consistent water supply to 600 million people.
- Expanding partnerships with research institutions, local partners, contracted farmers, etc.

Smart Farms

Creating secondary industries from primary industries at innovative plant factories

We are working to mitigate climate change risks, food shortages caused by population growth, and solve challenges faced by farmers by repurposing our existing technologies for use in new areas and working with external partners.

Progress in 2023

1 Invested in Oishii Farm Corporation

In August 2023, we invested in Oishii Farm Corporation. Oishii Farm is an American venture company that is working on a plant factory that combines Japanese agricultural techniques and technology. Strawberries are considered to be the most technically difficult crop to grow. Using natural pollination by bees, Oishii Farm has succeeded in consistently producing strawberries for the first time ever in a completely closed plant factory that is automated and that uses less labor. By appropriately controlling factors such as water, CO_2, temperature, light, and nutrition to suit the plants being grown, Oishii Farm is delivering quality produce to consumers year-round while optimizing the use of renewable energy, conserving water, and eliminating the use of pesticides.

Future Actions

- Combining Oishii Farm's expertise in operating plant factories and Ebara's strengths in water circulation, air conditioning, reduced energy consumption, and heat management technologies and manufacturing capabilities
- Seeking to create and expand secondary industries from primary industries (indoor plant factories that are less susceptible to the surrounding environment)