

Business Portfolio and Value Creation

DENSO operates seven core businesses in a broad range of domains, with particular emphasis on the mobility domain. The Company has built its business portfolio with a view to creating new value for the future and maximizing the value created by each business. Moreover, at present reweighting the business portfolio is a priority strategy. Even in a volatile operating environment, a reweighted business portfolio will allow us to market products and services that reflect demand and to continue to grow.

Business Composition

In its automotive businesses, DENSO supplies an extensive lineup of products and systems as a Tier 1 supplier that is trusted by car manufacturers around the globe. We have five automotive businesses: the Electrification Systems Business, which is pivotal to the popularization of electric vehicles; the Powertrain Systems Business, manufacturing powertrains for an array of different vehicles; the Thermal Systems Business, engaged in the manufacture of in-vehicle air-conditioning systems that account for the largest share of the global market; the Mobility Electronics Business, which aims to eliminate traffic accident fatalities; and the Advanced Devices Business, essential for mobility-related development going forward. These five businesses are contributing to electric vehicle popularization, advanced safety, automated driving, and connected driving. Meanwhile, our non-automotive businesses are leveraging technologies fostered in the automotive businesses to advance growth in the fields of factory automation (FA) and agricultural technology (AgTech).

Introduction of Sustainability KPIs

To further promote initiatives aimed at maximizing green value and peace of mind value, we introduced sustainability KPIs in fiscal 2023. One such KPI is a target for revenue from green and peace of mind products, which corresponds to the proliferation of these products. We have begun monitoring results in relation to this new KPI. DENSO's green and peace of mind lineup is steadily growing revenue and providing value throughout society.

Relationship between Companywide Strategy and Business Strategies

Business strategies linked to the Companywide strategy are key to realizing the Mid-term Policy for 2025 and achieving green and peace of mind strategies. We are maximizing the value we provide to society by steadily reweighting our business portfolio based on a Companywide strategy—which entails ensuring growth through the de-emphasis and discontinuation of internal combustion engine products—and by accelerating the development and sales growth of green and peace of mind products. In light of the current business

environment and the progress of business strategies, DENSO annually reviews, deliberates, and revises specific short-, medium-, and long-term scenarios that envision leveraging the distinctive advantages and capital of each business to realize the Companywide strategy. The following pages focus on the progress of business strategies linked to the Mid-term Policy for 2025 as well as specific green and peace of mind strategies.

Fiscal 2023 Summary

Global economy: The global economy trended toward modest recovery with the easing of COVID-19 pandemic-related restrictions on economic activities. On the other hand, the prolonged invasion of Ukraine by Russia and other factors led to worldwide shortages of energy and in-vehicle semiconductors as well as hikes in the prices of various goods and services. In addition, uncertainties persisted due to concerns that monetary tightening in the United States and Europe would lead to an economic recession and to turmoil caused by China's zero-COVID policy.

Revenue and operating profit: The Company posted record revenue and operating profit. Revenue increased 16.1%, or ¥885.8 billion, year on year, to ¥6,401.3 billion, as higher sales in the vehicle electrification and advanced safety fields coupled with a recovery from the impact of the operational restrictions imposed during the COVID-19 pandemic outweighed lower vehicle production, which resulted from a semiconductor shortage and other factors. Operating profit rose 24.9%, or ¥84.9 billion, year on year, to ¥426.1 billion, thanks to sales growth, rationalization that included R&D efficiency improvements, and the passing on of cost hikes to prices, which absorbed the effect of external factors such as the soaring cost of materials, logistics, energy, and components, particularly electronic components.

Principal Changes in the Business Environment (Future Opportunities and Risks)

Proliferation of electric vehicles: The pace of initiatives, regulatory implementation, and rulemaking that are aimed at realizing carbon neutrality is increasing. Meanwhile, large amounts of CO₂ are

emitted not only when conventional vehicles are used but also when vehicles are manufactured. Given these factors, interest is growing in the automotive industry's initiatives to popularize electric vehicles. According to the International Energy Agency, electric vehicles accounted for less than 10% of vehicle sales in 2021 but are projected to account for 36% by 2030. In 2030, approximately 80% of electric vehicles sold are expected to be BEVs. Further, China and Europe are likely to lead the growth in sales of electric vehicles. Accordingly, BEV-related product development and production capacity increases are being accelerated. (Electrification Systems, Powertrain Systems, and Thermal Systems [P.54–59](#))

Rising demand for in-vehicle semiconductors: Currently, the global semiconductor market accounts for revenues of approximately ¥50 trillion. This market is expected to grow steadily and reach ¥100 trillion by 2030. As a struggle for supremacy continues to unfold in the global semiconductor market, the in-vehicle semiconductor market is likely to see new growth due to the advent of a decarbonized society and technological innovation in mobility. Mainly reflecting increased demand accompanying the popularization of electric vehicles and automated driving, the growth rate of the in-vehicle semiconductor market continues to outpace that of the semiconductor market as a whole. (Advanced Devices [P.62–63](#))

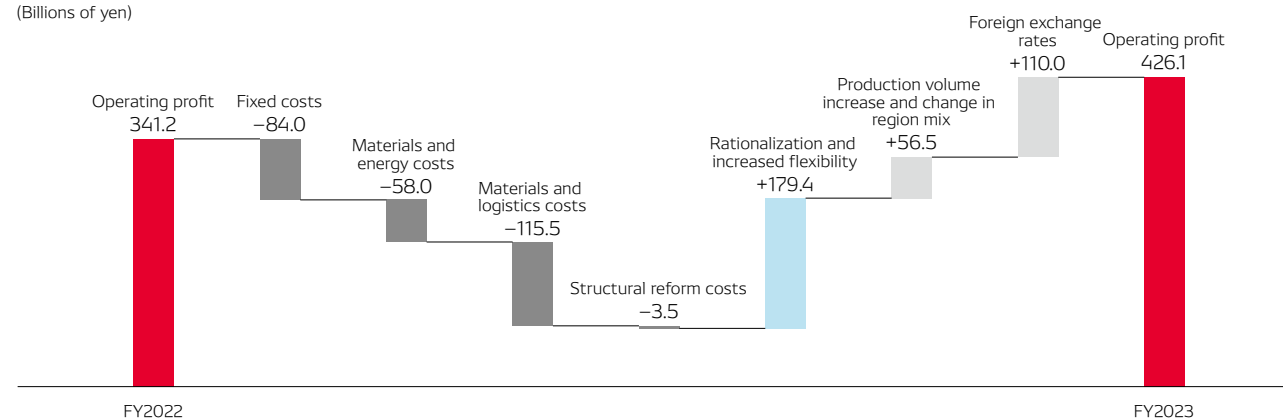
Increased utilization of in-vehicle software: As vehicles become more sophisticated due to the popularization of electric vehicles and the development of advanced driver assistance systems (ADAS), in-vehicle software is increasing in quantity and complexity. As for connected vehicles, which link with a range of objects, the use in recent years of over-the-air systems will enable wireless, remote software updates and performance improvements on an ongoing basis. In addition, due to the entry of IT companies into the automotive industry, competition with companies from other industries is becoming fierce. (Mobility Electronics [P.60–61](#))

Intensification of labor shortages: Since 2019, the number of people facing hunger worldwide has increased by approximately 122 million due to the COVID-19 pandemic, frequent climate-related crises, and conflicts in various regions, including Russia's invasion of Ukraine. Food insecurity is more pronounced among those living in rural areas, and the need for stable, large-scale agricultural production is only increasing. Also, labor shortages are becoming more serious, particularly in developed countries. A conspicuous example of this trend is the "2024 problem"* in Japan's logistics industry. In establishing a society that can sustain production activities, expectations are growing with respect to the comprehensive automation of plant production functions. (Factory Automation and Social Solutions; Food Value Chain [P.64–65](#))

* The "2024 problem" in logistics refers to the logistical delays that are expected to result from two regulations related to truck driver working hours, both set to take effect in April 2024.

Operating Profit: Breakdown of Positive and Negative Factors

(Billions of yen)



Industry-wide
De-Emphasis and
Discontinuation of
Internal Combustion
Engine Products

Since fiscal 2022, DENSO has been optimizing its business portfolio to maximize green value and peace of mind value. Our aim is to focus management resources on fields that contribute to profits and the realization of our management philosophy. To this end, we are considering the de-emphasis and discontinuation of internal combustion engine products in certain businesses. To establish a favorable model for DENSO and its customers and suppliers, as well as the companies assuming its businesses, the disposal of businesses will be premised on continuing to safely and reliably provide customers with products of the same high quality. Based on this premise, we have been de-emphasizing and discontinuing internal combustion engine products. To date, we have decided to dispose of type III alternator and fuel pump module businesses. In fiscal 2024, we announced our plan to begin examining the disposal of certain ceramic product businesses (as of the end of July 2023). Ceramic products are core components of internal combustion engines. The aim of transferring businesses engaged in the manufacture of these components to Niterra Co., Ltd., which has some of the world's leading technological capabilities in the ceramics field, is to integrate the technological and *Monozukuri* capabilities of both companies and thereby enable the realization of enhanced internal combustion engine components. In addition, DENSO will accelerate the development of products for electric vehicles in preparation for their full-scale popularization. At the same time, we will work on the development of energy management systems for entire vehicles, which will become increasingly important with the proliferation of electric vehicles. Through such initiatives, DENSO will offer products that are appealing to customers in terms of both performance and price across the entire automotive market, including internal combustion engines and electric vehicles, and contribute to the early realization of a carbon-neutral society. Going forward, the Company will optimize its business portfolio even more vigorously with the aim of continuing to provide society with new value.

Business Analysis

By utilizing technologies and expertise developed in respective businesses to realize products that meet current trends, DENSO has provided society with value. Today, each of our businesses continues to grow and transform itself based on business strategies that are linked to a Companywide strategy. This section provides a close-up on the achievements, advantages, strategies, and initiatives that will enable our businesses to continue providing value going forward—a topic that is often the focus of our dialogues with investors, analysts, and other external stakeholders.

Electrification Systems

Q: As the penetration of BEVs increases, how competitive will DENSO's inverters be?

A: DENSO has many different business segments and fields of expertise and will ensure competitiveness by offering system solutions that meet the expectations of markets and customers. For many years, DENSO has worked on improving entire systems, including battery control systems and thermal management systems. In other words, we approach improvements from the perspective of overall vehicle specifications. In addition, by evolving, improving, and utilizing the SiC power semiconductors that are incorporated into inverters, we will help enhance the driving distance of BEVs. Moreover, increasing the commonality between BEV inverters and those of hybrid electric vehicles (HEVs) will shorten lead times for bringing inverters to market and allow us to increase cost competitiveness by leveraging the volume of HEV inverters.

Q: Given that automakers are increasingly manufacturing electric drive components (motors and inverters) in-house, what is your strategy for growing sales?

A: Motors and inverters are as important to electric vehicles as engines are to internal combustion engine vehicles. Therefore, some customers prefer to insource the manufacture of electric drive components to keep workforces employed. With electric mobility demand diversifying globally, DENSO's mobility electronics and motor businesses give the Company in-house capabilities covering all stages of electronic product manufacture—from wafers through to components—as well as a development platform for the integrated in-house production of all sizes of motors, encompassing design, manufacture, and inspection processes. Thus, our strength lies in an ability to provide and contribute to systems in terms of mobility performance and quality. We can also provide standardized components and modules that meet diverse customer needs, thereby advancing the popularization of electric vehicles and helping the realization of a carbon-neutral society.

Powertrain Systems

Q: Could you please explain your future strategy for internal combustion engine products as the trend toward carbon neutrality gains momentum?

A: The spread of electric vehicles will accelerate mainly in Europe, the United States, and China. However, the pace of electric vehicle introduction will differ depending on the energy situation in each region and vehicle type, such as commercial, agricultural, and construction vehicles. To meet the wide variety of future demand, we

must provide a range of power source options with low environmental impacts. By leveraging technologies fostered for internal combustion engine products and developing engines that use hydrogen, biofuels, e-fuel, and other fuels with high energy efficiency and low environmental impact, we will support customers and industry as a whole in the current phase of transformation. In this way, we will contribute to the realization of environmental measures globally.

Thermal Systems

Q: DENSO's target is to realize capacity for the manufacture of 5.4 million thermal management products by fiscal 2031. Can you please explain this target as well as your strategies for sales growth and technologies?

A: By 2030, we expect that BEVs will have transitioned from an introductory phase to an "infancy" phase in which automakers adopt dedicated BEV platforms in earnest and begin mass production, leading to diversification of automakers' thermal management needs. Catering to diversifying needs risks increasing development man-hours and creating a bloated value chain for current thermal management systems, which are realized through the alignment of various functional components. With its sights set on the

mentioned infancy phase of BEVs, DENSO will further improve the core technologies established by the Thermal Systems Group, such as thermal control and system construction technologies and technologies for creating high-performance compact products and miniaturized products. These initiatives will enable the creation of differentiated products that heighten our competitiveness. In addition, we are formulating a concept that entails improving development efficiency through model-based systems engineering* and then integrating various component functions into modules. Through different combinations of these modules, we will create modular products tailored to meet the needs of each customer. To realize this concept, we will participate in the early development

phases of major customers, seek solutions to issues through our modules, and work with customers to clarify future requirements for the development of thermal management and to establish understanding of the value that should be realized. We will use these close collaborations to increase our sales even further. Also, DENSO is reorganizing its production and supply system so that it can deliver 5.4 million thermal management products. We are consolidating existing products in step with shrinking demand for internal combustion engine products and focusing the utilization of

facilities, personnel, and other existing assets on the thermal management area. DENSO has also begun examining reorganization that transcends business boundaries by utilizing the production bases and technological capital of other business divisions. Through these initiatives, we will achieve our sales growth target for thermal management products and achieve business portfolio transformation while maintaining our business structure and competitiveness.

* An engineering method that improves efficiency and quality by basing the entire systems engineering process, including business processes, on digital models

Mobility Electronics

Q: Electronic platforms are likely to see demand growth. What is your strategy for them?

A: As the introduction of software-defined vehicles (SDVs)* and BEVs advances, demand for electronic platforms will increase even more. DENSO has long been involved in electronic systems for entire vehicles, including the powertrains, bodies, chassis, cockpits, and ADAS. Consequently, we have accumulated extensive technological capabilities and expertise in electronics and software for entire vehicles. Further, over many years we have built networks with automakers around the world. In addition to these advantages, we will incorporate the latest digital transformation and automation methods to accelerate the development of electronic platforms that support the realization of highly appealing SDVs and BEVs.

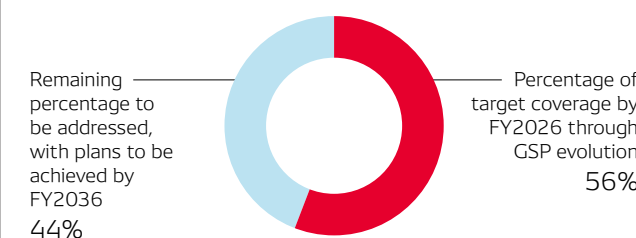
* Vehicles (or vehicle manufacturing) in which software plays a central role in the realization of electrification, automated driving, and vehicle security

Q: What is your road map for the development of ADAS technology?

A: We will further improve the performance of Global Safety Package (GSP), an advanced safety system. As shown in the chart, we will continue development with the goal of eliminating 56% of traffic accident fatalities by fiscal 2026. As for the remaining 44%, we will develop high-performance sensors that recognize hazards in the entire area surrounding vehicles and vehicle-infrastructure cooperative systems that detect hazards in vehicle blind spots. Moreover, for accidents

resulting from hazards that cannot be detected by GSP or vehicle-infrastructure cooperative systems, DENSO will develop technologies that monitor the driver's condition and skills. We will then develop algorithms that constantly monitor both the vehicle's surroundings and the driver's condition and integrate the acquired data. Through these system development efforts, we aim to eliminate traffic accident fatalities.

Percentage of Traffic Accident Fatalities Covered by GSP



Note: Estimated figures based on accident analysis conducted by the Institute for Traffic Accident Research and Data Analysis in 2018
Estimate subject: Fatal accidents in which passenger cars (standard motor vehicles or light motor vehicles) were the first party, excluding car-train accidents

Advanced Devices

Q: Could you please explain DENSO's SiC supply strategy, including external collaborations?

A: With the introduction of carbon-neutral regulations globally, automakers are accelerating product development to comply with them, and the spread of electric vehicles in the market is expected to advance rapidly. DENSO will seek differentiation by rolling out inverters with silicon carbide (SiC) semiconductors, which have lower loss, higher quality, and larger areas (8-inch diameter) than conventional silicon (Si) semiconductors. By doing so, we will claim a larger share of the market for electric vehicle inverters and contribute to the market penetration of electric vehicles and the reduction of CO₂ emissions. SiC power semiconductors with DENSO's unique trench-type metal-oxide-semiconductor structure*¹ improve the output per chip by simultaneously achieving high voltage and low on-resistance**² operation and by reducing power loss associated with heat

generation. This increased output extends driving distance. In addition, to increase the resilience of supply capabilities and ensure that we can stably supply SiC power semiconductors with the required quality in the same way that we do for Si power semiconductors, we will disclose patent-protected technologies and in-vehicle specifications and provide technical support to contracted manufacturers within the supply chain. Having been adopted by the Green Innovation Fund in 2022, this supply chain initiative is also utilizing a subsidy from the fund. Through development aimed at increasing the efficiency of energy management in vehicles, the initiative will help realize a carbon-neutral society.

*¹ Semiconductor devices with a trench gate that uses DENSO's patented electric field relaxation technology

**² A measure of the ease of current flow; the lower the value, the lower the power loss

Contribution Fields and Mainstay Products

Since its establishment as a manufacturer of electrical equipment and radiators, DENSO has reflected changes in society by extending the Company's business domain to encompass lifestyle-related and industrial equipment through the application of technologies that were originally developed for the automotive field. Through seven core businesses, DENSO is currently utilizing technologies accumulated in the automotive field to develop a range of businesses that will provide solutions for the mobility society of the future.

Value Creation in Our Businesses

In accordance with the Long-term Policy for 2030, our seven core businesses are pursuing innovations in leading-edge technologies to maximize the value of green and peace of mind. In addition, through our business activities, we will work to achieve the targets of the SDGs and create new value for the future mobility society.

Segment	Contribution to Long-term Policy for 2030 (Value of Green and Peace of Mind)	Fiscal 2023 Revenue Breakdown	Revenue (Billions of yen)	Relevant SDGs	Core Products That Contribute to Green and Peace of Mind
Automotive businesses	Electrification Systems	Green Peace of mind 16.3%	874.6 (FY22), 1,042.2 (FY23)	7, 9, 13	Power control units, Motor generators, Battery ECUs (Electronic control units), Lithium-ion battery packs, ESUs (Electricity supply units), Electric power steering motors and control units (Electric propulsion units), Control brakes (Motor: ECU), Power window regulator motors
	Powertrain Systems	Green Peace of mind 23.3%	1,324.5 (FY22), 1,489.3 (FY23)	9, 12, 13	Common rail systems, Gasoline direct injectors (High-pressure injectors, high-pressure pumps), Ignition coils, Spark plugs, Exhaust gas sensors, Variable cam timing (VCT) systems, Motorcycle products (ACG-S, ECUs), Starters, Alternators
	Thermal Systems	Green Peace of mind 24.8%	1,282.0 (FY22), 1,585.0 (FY23)	7, 12, 13	HVAC units, Condensers, Radiators, Bus air conditioners, Heat pump systems, Inverter cooling systems, Battery cooling systems, In-vehicle refrigeration units
	Mobility Electronics	Green Peace of mind 25.2%	1,356.4 (FY22), 1,615.6 (FY23)	7, 9, 17	Engine ECUs, HEV ECUs, BEV ECUs, Vision sensors, Millimeter-wave radar sensors, Integrated cockpit systems, Road-to-vehicle and vehicle-to-vehicle communication devices, Software incorporated into various systems, ECUs, and sensors
	Advanced Devices	Green Peace of mind 5.6%*	358.3 (FY22), 361.7 (FY23)	7, 9, 13	Multi-flow control valve (MCV-e) (Coolant water volume control valve for BEVs), Shift-by-wire system actuators, Accelerator pedal modules, Power cards, Semiconductor sensors, Application-specific integrated circuits (ASICs)
	Non-automotive businesses	Factory Automation and Social Solutions	Green Peace of mind 2.8%	186.9 (FY22), 177.1 (FY23)	2, 8
Food Value Chain		Green Peace of mind	Note: The year-on-year decrease in revenue was due to lower revenue from the cell phone agency business and other new businesses.	9, 17	Horticultural facility-related products (From left: Products for large and medium-sized greenhouses and horticultural facilities, systems for controlling the environment of greenhouses in Japan, and automated harvesting robots [Sales planned]), Compact mobile freezing and refrigeration units, QR traceability systems (Sales planned), Production source verification support systems (Sales planned)

* Revenue including semiconductors (power semiconductors, application-specific integrated circuits, sensors, etc.) produced internally for other businesses: ¥590.0 billion

ELECTRIFICATION SYSTEMS

Making electric vehicle components widely available and contributing to carbon neutrality

We provide products suitable for the energy optimization and market penetration of all types of vehicles.

To market electric systems that contribute to carbon neutrality, we have enhanced the performance, compactness, and fuel savings of key components that are essential for vehicles. Going forward, DENSO will leverage its broad business domain to connect all manner of vehicle systems and products and manage energy efficiently, thereby further improving fuel efficiency and extending driving distance. Moreover, by offering products suitable for market penetration, we will help reduce CO₂ emissions.



Katsuhiko Takeuchi
Head of Business Group

Business Strengths

System Development Capabilities

It has become increasingly important to improve the environmental performance of vehicles as electrification intensifies. To meet the needs of markets and customers, we provide systems that optimally integrate vehicle functions for driving, turning, stopping, and comfort. The DENSO Group offers the full range of components used in electric drive systems, the heart of electric vehicles. Based on a thorough understanding of how hardware is used, our system development capabilities heighten the overall performance and reliability of systems, thereby satisfying diversifying market demand.

Fundamental Technological Capabilities

After the development of electric vehicles roughly 70 years ago, we took on the challenge of developing winding technology—which became the core of our founding electrical equipment business—and achieving semiconductor production in-house. The electronics technologies established through these initiatives enabled us to realize power conversion capabilities, while we accumulated heat management capabilities by developing car air conditioners and radiators. In this way, we have evolved fundamental technologies for electric vehicles. We will expand and improve our product lineup by continuing to enhance the compactness and efficiency of fundamental technologies for components that are supported by world-leading technology relevance.*

Monozukuri Capabilities

At the Anjo Plant, the Electrification Innovation Center is rapidly and efficiently developing and introducing next-generation manufacturing technologies. For example, on the mass production lines of the adjoining electric vehicle component plant, the center is conducting verification tests of a CO₂ recycling plant and an energy-saving environmental production line that curbs CO₂ emissions. The Anjo and Hirose plants—which serve as mother plants in the electric vehicle component field—together with approximately 50 bases in Japan and 18 other countries will deliver high-quality components to customers worldwide.

Technology Relevance (based on research by DENSO)



* Technology relevance (TR) is calculated by using LexisNexis® PatentSight®. TR is an indicator calculated based on the number of citations of a patent compared with those of patents in the same technical field filed in the same year. The average TR of all patents is close to 1 as TR is relative to three factors: the number of citations, the filing year, and the technical field. With respect to calculation conditions, the search range was determined by referring to the search formula of the “high-efficiency motor inverters” middle category gxBO2, which is based on the Green Transformation Technologies Inventory categories provided by the Japan Patent Office. The leading 10 companies in the automotive industry in terms of the number of patent families were compared.

Business Strategy

In fiscal 2024, by anticipating diversifying needs through the development of a customer-driven product lineup and by establishing globally competitive production, safety, and quality capabilities that incorporate business continuity plans, we will not only build a system to support the production of more than 10 million BEVs by fiscal 2031 but also contribute to carbon neutrality.

Reinforcement of Business Foundations	To ensure that the production foundations are in place to underpin the transformation of its business portfolio, DENSO will maximize the use of existing HEV assets through their mixed utilization or utilization for other purposes. At the same time, we will introduce our leading-edge technologies, including automated logistics, digital transformation of production preparation processes, and robotic cell production lines capable of high-mix, low-volume production. As well as securing stable production and uninterrupted supply through the establishment of a global bridge production system and “nonstop” production lines with high-capacity utilization, we will improve quality levels by expanding systems that ensure equivalence. Through the aforementioned measures, DENSO will globally develop a new <i>Monozukuri</i> system befitting the age of electric vehicle proliferation.
Business Portfolio Transformation	Anticipating the diversifying needs of our customers, we will expand and enhance systems, components, and parts comprising the different strata of our product lineup. To minimize the risk of semiconductor depletion, we will strengthen in-house collaboration while bolstering partnerships with global semiconductor manufacturers without being constrained by existing frameworks. In addition, DENSO will grow sales and strengthen competitiveness by leveraging its accumulated weight reduction, low-loss, and electric system technologies to advance the development of new electromechanically integrated rotating machines that surpass segment conductor technology.*

* Proprietary winding technology that achieves compactness, lightness, and high output

Specific Initiatives to Achieve Strategic Aims Meeting Diverse Customer Needs through Core Products for Electric Mobility

BEVs are becoming an increasingly large part of the powertrain mix, especially in Europe, China, and North America. As the needs of customers diversify, our business models will also diversify. To respond swiftly to such diverse changes, DENSO’s electrification business must expand and enhance its lineup of core products, namely, inverters, motor generators, and battery management units. We will offer not only stand-alone components but also systems that bundle multiple components together. In other words, we will

Outcome of Strategies for “Green” and “Peace of Mind”

Objective: Provide electric drive system products with a view to carbon neutrality
Results: In response to a diversifying market, rolled out new products, including low-loss, high-output, compact SiC inverters that help enhance the practicality of BEVs by extending their driving distance, shortening charging time, and lengthening battery life. Selected electric drive systems, products, and components from our lineup that are suited to customer needs and market penetration and, focusing on energy management, established development capabilities and initiated projects for electric drive systems and products

Objective: Create new businesses and develop new products by applying the Group’s core technologies
Results:

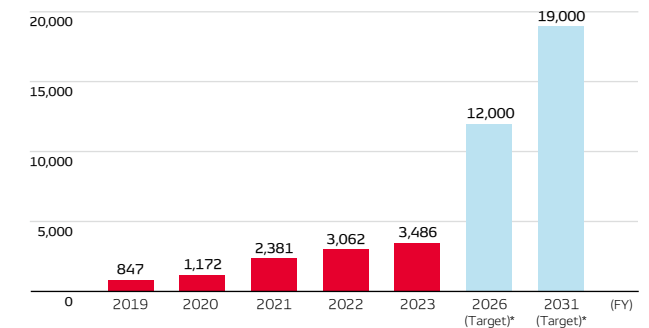
- Our project for the development of electric propulsion systems (motors and inverters) for electric aircraft adopted by the New Energy and Industrial Technology Development Organization (NEDO)’s Green Innovation Fund under the category of “Next-generation Storage Battery and Motor Development.” Strengthened collaboration with NEDO for real-world implementation
- Utilized our track record for in-vehicle electric power steering motor control units to advance the development of propulsion machinery for compact vehicles, such as in-plant automatic guided vehicles, autonomous mobile robots, and “last one mile” delivery robots

provide added value by marketing systems that link thermal management to competitive, electromechanically integrated systems, such as eAxle. Also, by providing power modules and other competitive modules and components, we will further deepen our ability to meet the needs of all types of customers and create business models together with industry-leading customers.

To prepare for global business expansion associated with BEV proliferation, we established mass production capabilities in North America and China in fiscal 2023, and we are building similar capabilities in Europe in fiscal 2024.

Unit Production of Inverters

(Thousands of units)



* Figures announced at DENSO DIALOG DAY 2022 in December of the same year

For details on the “Next-generation Storage Battery and Motor Development” project adopted by NEDO, please visit the website below.
<https://green-innovation.nedo.go.jp/en/project/development-next-generation-storage-batteries-next-generation-motors/>



Resolving Social Issues through Our Businesses

Relevant SDGs  

Inverter with SiC Power Semiconductors Enhancing the Driving Distance of BEVs through a Highly Efficient Inverter

We have developed and launched an inverter that utilizes SiC power semiconductors. This inverter is used in the new LEXUS RZ, released in March 2023 as the first dedicated BEV model. Our product has been incorporated into the eAxle, an electric driving module developed by BluE Nexus Corporation.

The aforementioned SiC power semiconductors are made of a semiconductor material that significantly reduces power loss. Inverters drive and control the motors that power BEVs. Compared with inverters that use conventional Si power semiconductors, our inverter that uses SiC power semiconductors in its drive devices reduces power loss by more than 50% under certain driving conditions,* helping to extend the driving distance of BEVs. Going forward, we will continue contributing to the proliferation of electric

vehicles by utilizing our technologies for mechanical parts and electronics to realize energy savings for all kinds of vehicles.

* Midsize SUV, driving mode stipulated by the United States Environmental Protection Agency: Federal Test Procedure (City Schedule)

Inverter with SiC power semiconductors: Approximately 7% improvement in electric mileage (reduction in vehicle loss) compared with conventional products



Inverter



Power card

POWERTRAIN SYSTEMS

Balancing the joy of life with vehicles with superior environmental performance—Providing solutions that help overcome this seemingly contradictory task

We will reduce the environmental burden of vehicles to the greatest extent possible and respond to the diversification of fuel and various environmental regulations, which are becoming stricter by the year. We will also work to supply high-quality systems and components. By doing so, we will strive to create and deliver new value in order to contribute to society as a whole.



Hisashi Iida
Head of Business Group

Business Strengths

R&D Capabilities That Have Led Development of World-First Products and Advanced Powertrains	Highly Reliable Manufacturing Technologies That Facilitate the Safe Driving of Vehicles	Personnel, Masters of Powertrains, Form Organically Coordinating Organizational Capabilities
DENSO has mass-produced a number of world-first products, such as common rail systems and a product that directly injects fuel in diesel internal combustion engines, while pursuing greater environmental performance in vehicles. Our core technologies and development capabilities are also compatible with the expansion of options for carbon-neutral powertrains, such as hydrogen and biofuel engines.	To enable the high-performance driving of vehicles, DENSO has refined its highly reliable manufacturing technologies that are integrated from materials preparation to molding and sintering, as well as its technologies for high-speed assembly and highly complex and precise processing at the micron-unit level. DENSO aims to sharpen its technological edge further by fusing together cutting-edge AI and digital technologies with robots and its accumulated skills and manufacturing knowledge.	In working with automakers on the creation of vehicles that can satisfy tough environmental regulations and withstand harsh operating environments, we have developed a varied range of professionals, each of whom has expertise in particular elemental technologies or technical skills and works in a team of professionals focused on vehicle specifications. In other words, we have advanced organizational capabilities that allow us to leverage specializations in all areas, from components through to systems.

Business Strategy

The Powertrain Systems Business has helped the spread of mobility by pursuing the simultaneous realization of lower environmental impact and convenience. The extensive experience garnered through these efforts has enabled us to acquire additional technologies and skills. Moreover, meeting the needs of markets and customers has developed and strengthened our personnel and organization. We have a responsibility to utilize these technologies and skills and thereby continue contributing to the realization of a sustainable mobility society. With a view to helping achieve a sustainable future while ensuring that all our personnel can continue working with cheerfulness, pride, and vitality, in fiscal 2024 we will continue efforts to de-emphasize and discontinue internal combustion engine products throughout supply chains and to commercialize new energy businesses (demonstrating the effectiveness of measures).

Business Portfolio Transformation	As the internal combustion engine market enters a period of maturity and contraction, the Powertrain Systems Business Group will transform its business portfolio, which developed during the previous period of rising production volume. In this way, we will establish a profitable structure that enables continued earnings even during a phase of declining production. At the same time, the business group has a responsibility to pass on the baton by shifting the freed-up resources—personnel, products, and money—to growth fields. Attempting to shift such resources as personnel, products, and money to growth fields in a short period would not only require excessive manpower and expenses but would also impact and burden a wide range of stakeholders, including customers and suppliers. Collaboration with other business groups to identify needs in growth fields and then swiftly initiating activities and making adequate preparations is extremely important. With this in mind, we will begin initiatives as soon as possible, complete preparations promptly, and de-emphasize and discontinue internal combustion engine products in a decisive manner that precludes backtracking.
Realization of Carbon Neutrality and the Creation of New Value	In the field of utilizing new sources of energy, such as hydrogen and exhaust heat, our activities have led many people to entertain great expectations of our efforts and express interest in them. On the other hand, to realize commercialization we must gain the genuine endorsement of the business partners who create, use, and buy our products. For this reason, demonstrating the tangible value of products is essential. In fiscal 2024, we will conduct commercial product installation and advance demonstration activities in relation to exhaust heat power generation, fuel cells, and carbon neutrality at DENSO FUKUSHIMA CORPORATION and prepare concrete plans for commercialization.

Specific Initiatives to Achieve Strategic Aims Preparatory Activities for the De-Emphasis and Discontinuation of Internal Combustion Engine Products

Our preparatory activities are ensuring the safety, reliability, and stability of our products and businesses. In other words, we are establishing conditions that will enable us to safely deliver products with reliable quality. Specifically, in de-emphasizing and discontinuing internal combustion engine products, we must put in place four key elements: quality, business conditions, products, and supply chains. Therefore, we will strengthen the foundations of quality, revise sustainable business conditions and product specifications, and reorganize supply chains so that they reflect changes in scale. In the internal combustion engine field—where the new investment of resources is likely to become challenging—we will advance the aforementioned preparatory activities in collaboration with customers, suppliers, and other stakeholders so that we maintain supplies of internal combustion engines for those continuing to require them due to regional or timeframe-related issues. In this way, we will help realize the multi-pathway development of powertrain systems.

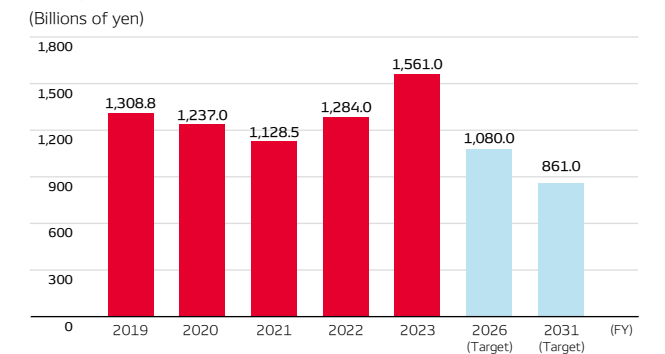
Outcome of Strategies for “Green” and “Peace of Mind”

Objective:	Promote efforts to de-emphasize and discontinue internal combustion engine products together with customers, suppliers, and other industry participants
Results:	Began discussions with customers and suppliers and initiated agreement on future strategies and scenarios; in fiscal 2024, expanding the scope and securing sufficient time for discussions and preparation by starting early
Objective:	Achieve commercialization in the new energy field through activities to promote related parties’ understanding
Results:	Through discussions with industry stakeholders, agreed on moving forward with various projects; in fiscal 2024, shifting to implementation by realizing commercialization through implementation demonstrations

Preparatory Activities

- Preparing quality (strengthening the foundations of quality)**
 - Eliminating dependence on the skills of individuals and creating processes not overly reliant on personnel
- Preparing business conditions (replacing businesses in our portfolio)**
 - Thinking through sustainable measures and establishing the required elements
- Preparing products (standardizing products)**
 - Establishing manufacturing that is easy to manage by improving the robustness of quality and by integrating product types to reduce component varieties
- Preparing supply chains**
 - Building a flexible production system in line with scale
 - Integrating the production lines of manufacturing bases and introducing high-mix, low-volume production lines

Revenue of Internal Combustion Engine Products Designated to Be De-Emphasized or Discontinued*



* Powertrain Systems Business Group overall

Resolving Social Issues through Our Businesses



Acquisition of Like-Minded Partners through Early Implementation of Demonstrations in the New Energy Field

With our sights set on a society where a range of energy-saving and renewable energy solutions become ubiquitous and energy and resources are used without waste, we have been creating core products that realize the concept of utilizing hydrogen, heat, and water, and we have been analyzing the value that these products offer. However, simply providing products that have value is not enough. Together with partners who share our vision, we must provide a value model that includes the establishment of suitable conditions. We will develop commercialization models that take into account safety, statutory regulations, infrastructure, regional characteristics, and economics, and together with our partners we will begin implementation demonstrations aimed at the start-up and expansion of operations.

Realization of Plant Decarbonization Technologies through On-site Hydrogen Production and Combustion Utilization at DENSO FUKUSHIMA CORPORATION



THERMAL SYSTEMS

Contributing to a more pleasant world by solving heat-related issues faced in a mobility society

With the arrival of a carbon-neutral society and the era of CASE vehicles,* the automotive industry is undergoing a paradigm shift. Amid this shift, the Thermal Systems Business Group is helping create the society of the future by taking maximum advantage of strengths as the leading global supplier of thermal systems to provide thermal management systems that increase the value of BEVs and realize comfortable, reassuring vehicle interiors.

* CASE vehicles: Connected, autonomous, shared & service, and electric vehicles



Yasuhiko Yamazaki
Head of Business Group

Business Strengths

Thermal Management Technologies	Relationships of Trust with Diverse Customers	Global Supply Chain
<p>A differentiating strength of the Thermal Systems Business Group is its thermal management technologies, which are backed by world-first products and approximately 2,400 patents—approximately 1.5 times more than those of competitors. We have built up these technologies through the development of cooling and air-conditioning products since our establishment. Due to the transition from internal combustion engines, which utilize engine heat, to BEVs, which have no heat source, demand for thermal management that efficiently controls heat in vehicles and utilizes it without waste is set to increase even further.</p>	<p>Through our mainstay heating, ventilation, and air-conditioning units and compressors, which firmly maintain the No. 1 shares of their respective markets, we have built relationships of trust with a wide range of customers, including not only Toyota Motor Corporation and other Japanese automakers but also European, American, and Chinese automakers, as well as manufacturers of commercial, agricultural, and construction equipment. DENSO will continue using its diverse customer network and nine technical centers located around the world to identify technological trends and needs worldwide and provide solutions based on thermal management technologies.</p>	<p>To enable the delivery of products to many different customers, the Thermal Systems Business Group operates more than 50 production bases in 26 countries around the world. We achieve optimal costs in each region through manufacturing that is rooted in regions. For example, we encourage local procurement and the rationalization of facilities on a regional basis. On the other hand, global supply networks and standardized product lineups enable the provision of inter-region production backup in emergencies. We will maintain and strengthen our global supply network through production reorganization in line with business portfolio transformation.</p>

Business Strategy

We will both help realize a carbon-neutral society and build a highly profitable business structure by advancing transformation of our portfolio from businesses that provide products for internal combustion engines toward businesses that offer thermal management products for BEVs.

Realization of Sustainability Management	To lay solid business foundations for business portfolio transformation, we will continue strengthening our ability to adapt to changes. For example, we will streamline operations, establish manufacturing that can adjust to fluctuating volume, and establish a system for using entire supply chains to mitigate market volatility.
High Aspirations and Meticulous Work	In catering to diversifying thermal management needs, transformation of development processes and manufacturing is essential. To simultaneously expedite development and heighten quality, DENSO will build an environment for model-based systems engineering development and entrench digital technology-enabled development processes. As for manufacturing, we will improve production efficiency through Factory-IoT (F-IoT) while realizing the concept of factory innovation through flexible production lines that incorporate the Core & Customization concept.
Business Portfolio Transformation	We will accelerate the development and sales growth of thermal management products for BEVs by transferring resources and assets freed up through the de-emphasizing or discontinuation of internal combustion engine products. In addition, we view the maintenance of supply chains and the discontinuation of businesses during the transitional phase of de-emphasizing and discontinuing internal combustion engine products as an issue for the entire automotive industry. Accordingly, we will give concrete form to exit strategies and co-create schemes that transcend the boundaries of customers, affiliates, and competitors.
Realization of Carbon Neutrality	Through increased sales of thermal management products, we will contribute to the popularization of BEVs, thereby helping realize a carbon-neutral society. Further, DENSO will step up carbon neutrality efforts throughout the value chain. For example, we will promote carbon-neutral materials that use recycled materials and begin demonstration tests of plants that achieve carbon neutrality through the utilization of renewable energy and hydrogen power generation.
Creation of New Value	We will solve thermal issues in fields beyond our traditional field of mobility by providing such products as air conditioners for air mobility and other new types of mobility and temperature controllers for computers compatible with self-driving cars.

Specific Initiatives to Achieve Strategic Aims Realization of a Scenario for the De-Emphasis and Discontinuation of Internal Combustion Engine Products with the Aim of Business Portfolio Transformation

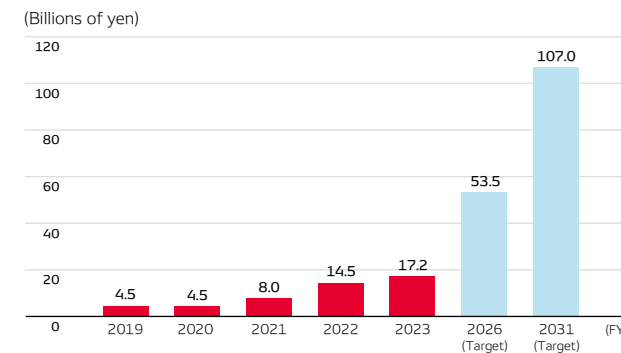
As BEV penetration accelerates, demand for internal combustion engine products will gradually contract. A major challenge going forward is the replacement of products in our lineup with thermal management products for BEVs while minimizing losses and fulfilling business obligations with respect to existing internal combustion engine products. Based on a strategy for internal combustion engine products formulated in fiscal 2023, the

Thermal Systems Business Group will work closely with customers and affiliates to realize a scenario for reorganizing and consolidating the global production of internal combustion engine products. In addition, to maximize the use of existing human resources, technological assets, and production foundations for the thermal management products of the next generation, we will tackle as an industry issue the building of a reorganization scenario that has continuity in all aspects, including technological development, human resource development, and manufacturing.

Outcome of Strategies for “Green” and “Peace of Mind”

Objective: Complete planning for the de-emphasis and discontinuation of internal combustion engine products	Results: Based on internal combustion engine products, which will see contraction as BEVs are introduced, completed formulation of strategies in line with the business phase of each product (mature, late stage, end stage); in addition, activities underway to maintain competitiveness during the transitional period, including revision of appropriate selling prices to reflect business phases, establishment of optimal production systems, and cost reductions through the use of general-purpose materials
Objective: Complete conceptualization of thermal management modules incorporating differentiated technologies	Results: Completed product concepts and strategy development; became involved in the early stages of our main customers' vehicle development and began product development; aiming to realize concepts during fiscal 2024

Revenue of Thermal Management Systems



Driving distance: 20% increase

One barrier to the proliferation of BEVs is driving distance, and a factor that limits driving distance is the electricity consumed for heating. DENSO's heat pump systems use heat in the air as a thermal source for heating, thereby reducing the consumption of electricity and greatly extending driving distance. Moreover, thermal management systems that use heat pumps enable the efficient adjustment of temperatures in vehicles and the cooling of batteries, which helps to inhibit battery degradation and shorten recharging times.

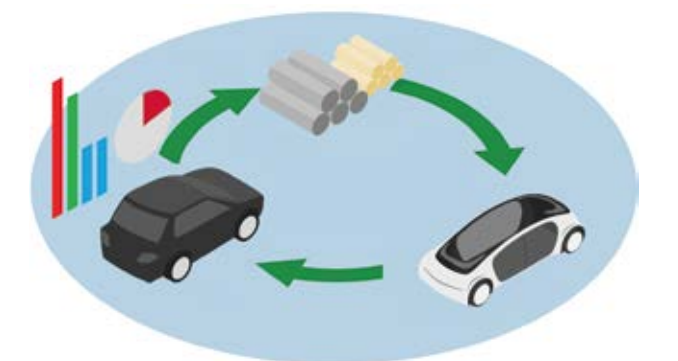
Resolving Social Issues through Our Businesses



Reduction of CO₂ Emissions throughout Product Life Cycles by Utilizing Recycled Materials

Aluminum is the main material of heat exchangers, and the large amount of electricity needed to refine this metal is an issue. As well as efforts to realize carbon-neutral *Monozukuri* through energy savings and the use of renewable energy, we are involved in materials development, entailing the development of technologies that utilize post-industrial recycled*1 materials. Through these efforts, we aim to significantly reduce CO₂ emissions during the aluminum refining process. Our goal is to help realize a recycling-based society by reducing energy utilization and CO₂ emissions throughout product life cycles and by utilizing materials in ways that minimize resource requirements. To these ends, we will establish products with environmentally friendly designs that incorporate post-consumer recycled**2 materials and introduce the repair and restoration of products themselves.

*1 In-house reuse of end materials by a materials manufacturer
**2 Reuse of scrap materials that are on the market



MOBILITY ELECTRONICS

Realizing a society in which all people can access mobility conveniently and with peace of mind (enhancing the quality of mobility)

DENSO helps realize zero traffic fatalities and carbon neutrality by continuing to introduce products in tune with the times, using its software and electronics technologies (sensors, semiconductors, ECUs), while precisely understanding the needs of users and advances and developments in society brought about by the CASE revolution.



Hiroshi Kondo
Head of Business Group

Business Strengths

Ability to Create Large-scale Integrated Systems from an All-Vehicle Perspective

Needs for electronic systems in the CASE era are evolving into large-scale systems that integrate and coordinate powertrains, bodies, chassis, cockpits, advanced driver assistance systems (ADAS), and other single-domain control systems. DENSO has experience in all of these systems. We create compelling products from an all-vehicle perspective with a broad range of technological capabilities.

Product Development Capabilities with Reliability and Sophistication Accumulated in Automotive Products

Automotive products must realize high quality and performance in harsh environments and under operational restrictions. We have been engaged in the automotive electronic product business for many years, ever since vehicles began to become more electronic, and we have accumulated extensive knowledge of vehicles as a result. DENSO develops competitive products through a combination of this knowledge with the latest electronics and software technologies.

Global Network

DENSO has honed its human capital, intellectual assets, and a global production structure by overcoming numerous obstacles with automakers around the world. Using these strengths, we will refine our CASE-related technologies while providing various solutions to customers, thereby moving the world one step closer to safe mobility that provides peace of mind and is environmentally friendly.

Business Strategy

With the transition to software-defined vehicles (SDVs) and BEVs, electronic platforms are undergoing major renewal, and the mobility electronics market is polarizing into the traditional field of single-function electronic control units (ECUs)*¹ and the growth field of large-scale integrated ECUs.*² Using this shift as an opportunity, we will develop and grow our businesses through portfolio management that strengthens our presence in the growth field.

*¹ Engine ECUs, etc. *² ADAS ECUs, etc.

Creation of New Value	<p>We aim to sustain business growth by improving our electronic platform planning capabilities and elemental technologies, both of which contribute directly to heightening the product appeal of SDVs and BEVs.</p> <ul style="list-style-type: none"> Supported by our comprehensive knowledge of vehicle-related electronics and software, we will work very closely with customers and jointly develop electronic platforms with the aim of creating new added value. Further, increased sales of ECUs based on these optimized electronic platforms will enable us to further lower costs by taking advantage of the economies of scale resulting from mass procurement and production. Through the development of ECUs, we will hone our in-vehicle software, semiconductors, and manufacturing technologies and increase the automation and speed of software development. We will utilize these technological assets—which are our strengths—to contribute to the development of the automotive industry.
Business Portfolio Transformation	<p>With our sights set on further growth of the safety systems business, we will expand our lineup of products that cater to specific market segments and regions and move forward with global rollouts. We will also focus on the software business and the development of electronic platform products for BEVs with the aim of creating new value. At the same time, we will identify businesses that do not conform to the green and peace of mind principles as well as products that are becoming commoditized and replace them in our portfolio systematically and in close coordination with our customers.</p>
Realization of Carbon Neutrality	<p>We will help achieve carbon neutrality by advancing the formation of a circular economy through contributions to the increased introduction of BEVs, the utilization of F-IoT to visualize manufacturing issues, the sourcing of recycled materials, the development of repair technologies, and the development of products with structures that facilitate disassembly.</p>
Realization of Sustainability Management	<p>By establishing business foundations that are adaptable to change, we will achieve sustainability management.</p> <ul style="list-style-type: none"> Development system reinforcement: With the aim of achieving large-scale, cross-domain software development, DENSO will redeploy human resources through portfolio management while developing and enhancing the capabilities of globally competent personnel through the Company's distinctive training system. Manufacturing competitiveness: In anticipation of the mass production of large-scale integrated ECUs, we will further refine and combine our strengths, namely, in-vehicle quality, mass production, and adaptability. In addition, we will collaborate with external manufacturing partners to strengthen our global manufacturing foundations and increase their resilience in changing conditions.

Specific Initiatives to Achieve Strategic Aims Initiatives Aimed at the Growth of the Safety Systems Business and New Value Creation

(1) Safety systems: To meet global customer needs, we will expand our lineup of products that cater to specific market segments and regions. In addition, through collaboration between initiatives for ADAS and human-machine interface (HMI), we aim to evolve recognition and estimation algorithms and grow cross-domain ECUs. (To this end, the AD & ADAS Business Unit and the Cockpit Systems Business Unit were integrated to form the Safety Systems Business Unit in January 2023.)

(2) Advancement of BEV electronic platform planning and development for individual vehicles: To respond to market evolution, we will evolve the Core & Customization design approach and cater to respective automakers and grades.

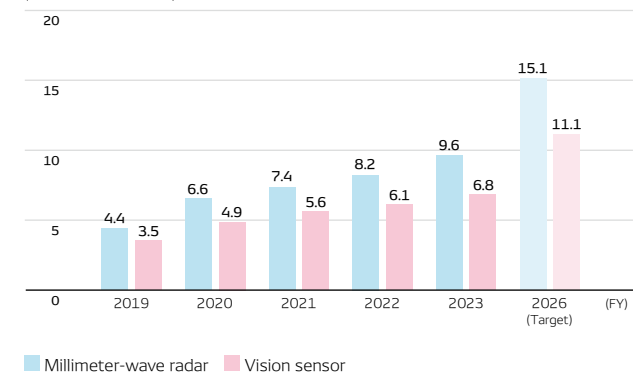
(3) Strengthening of software development capabilities: We will increase the percentage of automation and promote the use of AI. (Message from the Chief Software Officer [P85](#))

(4) Stable procurement of semiconductors and strengthening of competitiveness: The Company will promote stable procurement by standardizing components and sharing medium- to long-term strategies with partners. Also, we will achieve differentiation by using proprietary technologies to realize compact products that consume less power.

Outcome of Strategies for “Green” and “Peace of Mind”

Objective:	Popularize ADAS with a view to eliminating traffic accident fatalities
Results:	Increased the penetration of Global Safety Package 3 (GSP3),* featuring heightened safety performance * A system that uses millimeter-wave radar and vision sensors to assist driving
Objective:	Augment product lineup and develop electric, low-power consumption control systems with a view to carbon neutrality
Results:	As well as offering a lineup of hybrid electric vehicle (HEV), plug-in hybrid electric vehicle (PHEV), and BEV products, advanced the development of low-power ECUs and electronic control systems that help lower power consumption and electronic platforms that minimize energy usage by optimally integrating control of all vehicle systems

Number of Millimeter-Wave Radar and Vision Sensors Produced (Millions of vehicles)



Vision sensor detection angle: 128 degrees (28-degree increase versus other companies)
Millimeter-wave radar detection angle: 103 degrees (13-degree increase versus other companies)
Note: Detection angles based on DENSO's measurements

Global Safety Package (GSP) is a system that assists driving by combining a millimeter-wave radar that detects the shape of objects on the road, such as vehicles and guardrails, and a vision sensor that uses a camera to detect the environment ahead of the vehicle. Widening the detection angles of the system enables it to provide assistance in a greater variety of situations that could lead to accidents, such as assisting in collision avoidance at intersections. Further, the GSP system has received the highest rating in the automobile safety tests conducted in Europe by the European New Car Assessment Programme (Euro NCAP).

Resolving Social Issues through Our Businesses



Technology Evolution and Product Rollouts Helping to Eliminate Traffic Accident Fatalities

To eliminate traffic accidents and realize unrestricted mobility, we must further evolve safety products and equip vehicles with leading-edge technologies. At the same time, we must promote the incorporation of these products and technologies into as many vehicles as possible by developing attractively priced products. In fiscal 2023, we began full-fledged mass production of third-generation GSP system GSP3, which equips vehicles with the leading-edge AI and sensor technologies that are our forte, thereby greatly increasing the range of accidents that this system can prevent. In this way, we are extending the areas in which we provide value in the form of peace of mind. As it realizes compactness and low cost, GSP3 is significantly contributing to the popularization of safety products. DENSO

will continue developing advanced driver assistance-related technologies with the objective of achieving a mobility society that ensures the comfort and peace of mind of drivers, pedestrians, and greater society.



GSP3 millimeter-wave radar



GSP3 vision sensor

ADVANCED DEVICES

Creating and growing businesses that solve issues faced by society and customers beyond the mobility domain

As a company reorganized to go beyond technologies and focus more on helping society and our customers, we are collaborating on the sensing and actuation fronts, and enhancing the value of systems through semiconductors that leverage our strengths derived from vertical integration. While creating new devices and systems, we aim to win the trust of our customers with an all-points approach to quality, cost, and delivery (QCD) in the expanding electrification market.



Yoshifumi Kato
Head of Business Group

Business Strengths

Creation of New Value with Sensing and Actuation

Within the business group, our core technologies in actuation (i.e., hands and legs) are combined with semiconductors (i.e., brains) and sensing (i.e., eyes) to create new devices and systems based on nimble concepts, enabling the development of “great-if-possible” solutions for issues faced by our customers.

Leadership That Drives Collaboration with Partners and External Production Contractors, in Addition to Internal Production of Semiconductors

In preparation for expansion in the electrification market, DENSO will internally produce silicon (Si) and silicon carbide (SiC) power semiconductors, which are key devices that incorporate world-first technologies. Moreover, we will build the supply chain needed to increase cost competitiveness and supply capabilities.

On-site Capabilities That Support Production Technologies Highly Resilient to Changes in Specifications and Volumes in New Product Domains

DENSO is broadening the scope of applications for new product domains where it is competitive, thanks to human resource development and handpicked young employees. DENSO leverages digital-twin technology and collaborative robots to build a production system that can be optimally organized and configured by changing production line shapes and locations in accordance with fluctuations in volumes for new products.

Business Strategy

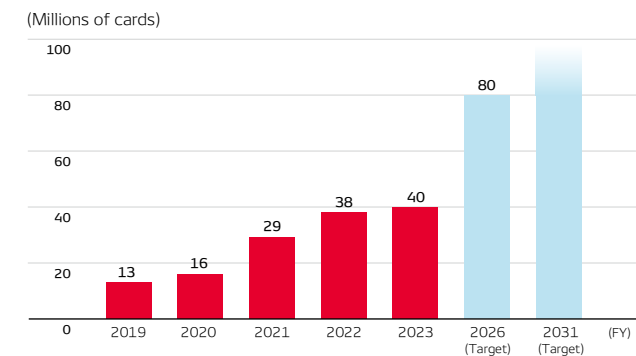
We will formulate winning scenarios and create new businesses through outstanding technological capabilities, speed, and alliances.

High Aspirations and Meticulous Work	To steadily transform our business portfolio from internal combustion engine products toward products for CASE vehicles, we will build variable-mix, variable-volume production lines that can adapt to product replacement and business environments with significant volume fluctuations. In addition, by digitalizing the expertise and knowledge of operators, we will take on ambitious production innovations that facilitate unmanned and nonstop production and compensate for a decline in the working age population.
Realization of Carbon Neutrality	As the presence of BEVs increases, we will capture demand in the vehicle electrification market through a two-pronged strategy of continuing our existing in-house production of inverter systems while establishing a business for the provision of modules catering to customers’ growing preference for producing inverters in-house. Also, we believe that the key to competitiveness will be the establishment of supply capabilities for the SiC used in BEVs. Going beyond conventional approaches, DENSO will efficiently and swiftly build a broad-based supply chain.
Creation of New Value	<p>The use of batteries is diversifying from primary to secondary usage as the introduction of BEVs gathers momentum. Given this trend, we believe that predicting battery life and reducing fire risk are important tasks. Through collaboration with other companies, DENSO will create and realize the widespread adoption of its differentiated products for sensing the health of batteries over their lifetimes, thereby providing additional safety and peace of mind when reusing and recycling batteries.</p> <p>We will identify the changes in electronic platform-related demand—which are accompanying the evolution from function-specific ECUs to the division of vehicles into multiple zones and the use of large-scale integrated ECUs controlled by central ECUs—and use semiconductor technologies to help enhance the value of systems. At the same time, DENSO will achieve business growth by increasing supply stability through alliances and outsourcing. In addition, we will support vehicle electrification by setting our sights on 2030 and accelerating the development of products for the next generation and beyond and by leveraging vertical integration to expand our lineup of control integrated circuits (ICs) for power semiconductors.</p> <p>We aim to establish multiple businesses in such areas as electric drives, human-machine interfaces, and thermal management as well as in non-mobility fields, including agriculture and plant logistics. In the CASE field, through the use of sensors and auxiliaries, DENSO will enable analysis of the energy management of individual vehicles and the optimization of system efficiency not only for such main components as batteries, motor generators, and inverters but also for other components. In these ways, we will benefit customers and society.</p>

Outcome of Strategies for “Green” and “Peace of Mind”

Objective: Begin collaboration with a chip foundry to meet growing demand for automotive semiconductors
Results: In April 2022, concluded an agreement to collaborate on the production of insulated gate bipolar transistors (IGBTs) at a 300-mm wafer plant operated by United Semiconductor Japan (USJC), the Japanese subsidiary of United Microelectronics Corporation; in May 2023, began IGBT shipments; and combined USJC’s wafer production technologies with DENSO’s system-targeted IGBT device and process technologies

Number of Power Semiconductors Produced (Power Cards)



SiC power semiconductors: Power losses approximately 70% lower than conventional Si devices

Inverters drive and control the motors that power BEVs. Compared with inverters that use conventional Si power semiconductors, our inverters that use SiC power semiconductors in their drive devices reduce power loss by approximately 70% under certain driving conditions. Consequently, our SiC power semiconductors help extend the driving distance of BEVs by increasing their electric mileage.

Specific Initiatives to Achieve Strategic Aims Beginning to Equip Vehicles with Inverters That Use SiC Power Semiconductors

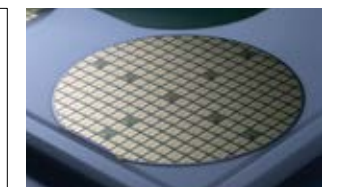
Our first inverter to use a SiC power semiconductor has been incorporated into the eAxle electric driving module. This module has been installed in the new-model RZ, unveiled as the first dedicated BEV LEXUS in March 2023. In the manufacture of power semiconductors, we have halved the number of crystal defects that cause disruption in the atomic arrangement of crystals, which prevents devices from operating properly. This improvement has been achieved based on the application of quality enhancement technology jointly developed by DENSO and TOYOTA CENTRAL R&D LABS., INC., and through the utilization of SiC epitaxial wafers,* which incorporate the results of work commissioned by the New Energy and Industrial

Technology Development Organization (NEDO). The aforementioned reduction of defects ensures in-vehicle quality and contributes to stable production of SiC devices.

* These are wafers formed by growing a thin film of crystals on a substrate of SiC crystals so that the upper layer of crystals aligns with the crystal plane of the substrate.



SiC power card



SiC power semiconductor wafer

Resolving Social Issues through Our Businesses



Helping to Address Global Water Shortages by Automating Agricultural Irrigation Systems

We are creating new solutions by connecting core sensing and actuation technologies developed in the mobility field. In the field of agriculture, for example, the shortage of water for global grain production has motivated us to launch an initiative tasked with applying variable flow technology used for engine coolant control valves to agricultural irrigation systems. In a demonstration test that used this technology on a farm, water savings of more than 30% were achieved compared with irrigating at a constant discharge rate. Moreover, we are

combining the technology with soil sensors that measure the appropriate moisture content and pressure sensors that detect water leakage and blockages, thereby demonstrating the value of the system as an automatic irrigation system. We are already in discussions with a global manufacturer of agricultural systems with a view to commercialization of the system, and we aim to start up mass production in 2025. In non-mobility fields, we will utilize and develop our core technologies to benefit initiatives that address such issues as labor shortages, population aging, and the realization of carbon neutrality.

FACTORY AUTOMATION AND SOCIAL SOLUTIONS

FOOD VALUE CHAIN

Enhancing the productivity of the *Monozukuri* industry and improving quality of life

Our mission in the Industrial Solutions Business Unit is to realize carbon-neutral *Monozukuri* (manufacturing) from the perspective of “green,” and to build a society that expands human potential from the perspective of “peace of mind.” Guided by this mission, we will work to earnestly address the issues facing our customers, providing them with solutions that resolve such issues in a manner that best suits their needs. By doing so, we will make significant contributions to industrial and social progress.



Jiro Ebihara
Head of FA Business
Development Division

Business Strengths

Production Assets That Have Been Rigorously Honed in the Frontline Manufacturing Operations of Approximately 130 Plants Worldwide

Using our high-quality, highly durable facilities that have been refined on auto part production lines, as well as our core factory automation equipment, such as robots and sensors, we are playing a role in improving productivity throughout the manufacturing industry and society at large while spreading our reach from stand-alone equipment to processes and modules.

***Monozukuri* Know-How That Has Supported DENSO's Products for More Than 70 Years**

DENSO solves serious issues directly affecting the manufacturing industry, such as labor shortages, carbon neutrality and digital transformation (DX), with its know-how in flexible and lean manufacturing and lean automation technologies.

Safe and Secure Solutions for Society Using QR Codes® Developed by DENSO

DENSO creates value for new domains and applications by incorporating outside ideas for using QR Codes® and QR Code® reader technologies that have been evolving since 2000 and which have become an international standard (ISO/IEC 18004).

Resolving Social Issues through Our Businesses

Relevant SDGs



Contributing to the Creation of Industrial and Social Settings Where People and Robots Work Together

DENSO has begun marketing COBOTTA® PRO, a high-speed human-collaborative robot. This new offering achieves industry-leading speed by employing a light, high-rigidity torque sensor that we developed in-house. At the same time, the robot's high-performance contact sensors and a touch-sensing soft cover ensure safety, helping to create industrial and social settings where people work confidently with robots. We are offering solutions not only in areas where robots have been deployed in the past—such as for simple tasks, assembly, and inspection in the manufacturing industry—but also in new areas where automation and collaboration between humans and robots has been considered difficult, such as the weighing, measuring, and serving of food in the food industry. (In recognition of its advanced features, COBOTTA® PRO received a Good Design Award in October 2022.)



COBOTTA® PRO

Note: COBOTTA is a registered trademark of DENSO WAVE INCORPORATED.

Focusing on Addressing Industrial and Social Issues as Creator of the QR Code®

In line with its efforts to create a society where everyone can enjoy a more fulfilling life, DENSO contributes to initiatives that are based on premium merchandise coupons. Many municipal authorities conduct such initiatives to stimulate regional economies. Consequently, the use of digital premium merchandise coupons is increasing. However, some people are being left behind because they do not own compatible devices or are not conversant with digital technologies. In response, DENSO has

developed the QR Code Subsidy Application System, which combines paper merchandise coupons and QR Codes®. Our system provides merchandise coupons and QR Codes® usable by anyone while streamlining the administrative work of municipal authorities and affiliated stores. We have completed provision of the system to an initiative based on merchandise coupons in Nakano Ward, Tokyo. Currently, DENSO is proposing adoption of this system to municipal authorities nationwide.

Providing a Medication Management Service That Contributes to a Healthy, Reassuring Society

One of the challenges associated with society's accelerated aging is the enhancement of home medical care. As the number of patients who take numerous medications at home increases, the provision of error-free environments for taking medications is becoming more important than ever. In addition, pharmacies need to realize centralized medication management and pharmacological guidance. To address these issues, DENSO has collaborated with a healthcare service company to develop a medication management service that utilizes IoT and automatic recognition technology. In the patient's home, a medicine box with communication functions is installed, which automatically detects and records the medication taken out and shares information on medication status with the pharmacy, family members, and other related parties via a server. This service will not only promote safe, reassuring medication management but also help mitigate the financial impact of unused medications on the medical insurance system.



Medicine box with communication functions

Combining technologies and ideas to provide new value and contribute to a society where all people can live safely and with peace of mind

Food is essential to human life. Together with our business partners, while observing the entire food value chain, we will provide solutions that deliver food safety and security to each region of the world, anytime, anywhere, and to anyone, forever.



Hidehiro Yokoo
Head of Food Value Chain Business
Development Division

Business Strengths

Greenhouses That Ensure Reliable Harvests While Dealing with Labor Shortages and Climate Change

By applying our *Monozukuri* technologies gained with automobiles to agricultural production, we are supporting technologies that condition environments for reliably harvesting agricultural products. We introduce automation technologies to create environments where people can move around easily, and globally supply solutions for greenhouses in a highly productive way that sustains growth.

Portable Compact Freezer/Refrigerators That Help Deal with Driver Shortages and Delivery Diversification

We provide portable freezer/refrigerators by utilizing heat control technologies developed for automobiles and by creating compact, light versions of conventional automotive freezers. Our battery-powered products allow non-specialized drivers with passenger cars to flexibly deliver a range of small-lot items without using engines or dry ice for freezing or refrigeration, which reduces CO₂ emissions.

New Distribution DX Solutions That Reflect Changing Needs in Food Distribution

Utilizing the QR Code® and RFID technologies, which we developed in frontline manufacturing operations, we are digitizing diverse information related to food in order to visualize food distribution information from production to sale, in response to consumer needs for safe and secure food. We also offer a straight-through food distribution platform that facilitates supply-demand optimization in distribution operations and rightsizes inventories.

Resolving Social Issues through Our Businesses

Relevant SDGs



Stabilizing Food Production by Introducing Industrial Approaches to Agriculture

Concern is growing over the food shortages that could result from instability in agricultural production due to climate change and a global decline in farming populations. In the field of horticultural facilities, we aim to utilize our vehicle manufacturing technologies to facilitate the introduction of industrial approaches to agriculture, thereby enabling anyone, anywhere to realize stable agricultural production.



Greenhouse for medium-sized and large farms



Robot for automated tomato harvesting

Specifically, we have partnered with the Dutch company Certhon Build B.V., which possesses leading-edge horticultural facility technologies. By combining these technologies with our automation, environment control, and digital transformation technologies, we will create and globally market highly efficient greenhouses suited to the characteristics of each region.

Also, DENSO will contribute to regional revitalization through the realization of sustainable agricultural production. Based on a comprehensive partnership agreement concluded with the city of Date in Hokkaido, we plan to develop a business that will become a model for regional revitalization. The new business will use environment control technologies to achieve year-round cultivation of high-quality crops, foster next-generation agricultural personnel through the introduction of a remote cultivation system that digitizes greenhouse data, and utilize local resources to establish low-carbon agriculture.

Promoting Local Production for Local Consumption through Temperature-Controlled Logistics and Product Exchanges between Roadside Stations

Based on a comprehensive partnership agreement with Kumamoto Prefecture, we are conducting verification tests of a model in which portable compact freezer/refrigerators are used for the exchange of products between roadside stations (rest stops). By enabling the transport of fresh food products between these stations, the model will solve the problems of opportunity losses due to insufficient stocks of fresh food products and waste due to surplus stocks. As a result, the model will encourage local production for local consumption and reduce food waste.



Portable compact freezer/refrigerator

Enhancing the Product Branding of Municipal Authorities through Production Source Verification Systems

We are contributing to safety and peace of mind in relation to food through the use of a QR Code® to visualize food distribution data. In response to the problem of the intentional mislabeling of short-necked asari clams to falsely show Kumamoto Prefecture as their production region, we have collaborated with the prefecture to jointly develop and introduce a system that uses our QR Code® to certify the production region. Thus, the system delivers safety and peace of mind to consumers by ensuring traceability from production through to sales. Going forward, we plan to roll out the system for a wide range of other regional products.



Rendering of the QR Code® being used to read production region data