Business Portfolio and Value Creation

DENSO operates seven core businesses in a 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 enabling respective businesses to resonate together as they maximize value creation. 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

As a company trusted by automakers worldwide, DENSO supplies an extensive lineup of products and systems, mainly through its automotive businesses. We have five automotive businesses: the Electrification Systems Business, which is pivotal to the popularization of electric vehicles; the Powertrain Systems Business, developing and 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 through systems that realize advanced safety functions by incorporating high-performance sensors and radar; and the Advanced Devices Business, providing semiconductors and other devices that are essential for mobility-related development going forward. By promoting electric vehicle popularization, advanced safety, automated driving, and connected driving, these five automotive businesses are leading our progress toward the new mobility that society seeks. Our non-automotive businesses are leveraging technologies fostered in the automotive businesses to develop businesses in the fields of factory automation (FA) and food and agriculture (AgTech).

Relationship between Companywide Strategy and Business Strategies

Business strategies closely integrated with 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 also takes into consideration the advancement of the entire industry and 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. Further, we are enhancing efficiency through Companywide efforts to reduce fixed costs, reassign human resources, and promote dialogue that enhances engagement and safety awareness.

In light of the current business environment and the progress of business strategies, DENSO annually reviews, deliberates, and revises 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 and accomplishments under the business strategies of each business, which are integrated with the Companywide Mid-term Policy for 2025.

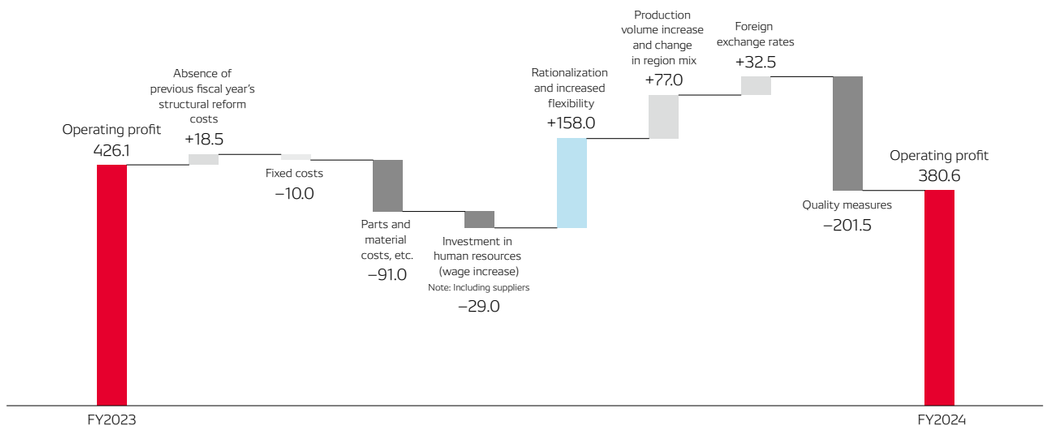
Fiscal 2024 Summary

Global economy: The global economy showed resilience and continued recovering gradually, despite continued uncertainty due to concerns that monetary tightening in the United States and Europe would produce an economic recession and to sluggish growth in China and emerging countries.

In the United States, interest rates remained high, with the U.S. dollar appreciating against the currencies of various countries. In addition, although the global inflation rate came down from its 2022 peak, the trend toward rising consumer prices and wages continued in many countries. Disputes with attendant geopolitical risks whose actualization could potentially disrupt logistics and lead to hikes in material prices continued to smolder. These disputes included Russia's prolonged invasion of Ukraine and instability in the Middle East.

Revenue and operating profit: Against the backdrop of a pickup in vehicle production due to an easing of the semiconductor shortage, sales of electric vehicle components and safety and peace of mind products rose, resulting in an 11.6% increase in revenue year on year, to a record high of ¥7,144.7 billion. Operating profit declined 10.7% year on year, to ¥380.6 billion, due to the establishment of a provision for quality measures amounting to ¥201.5 billion mainly related to fuel pumps, which outweighed the effect of steps to increase production volume, rationalize, and pass on cost increases to prices. Nonetheless, these steps offset hikes in parts and material costs, centered on electric vehicle components, and hikes in labor costs.

Operating Profit: Breakdown of Positive and Negative Factors
(Billions of yen)



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

Proliferation of electric vehicles: The electrification of cars is attracting attention amid the worldwide acceleration of initiatives, regulatory enforcement, and rulemaking aimed at the realization of carbon neutrality. BEVs are likely to account for more than half of the world's vehicle production by 2035, with particularly high growth rates expected in Europe and China. While the transition to BEVs is set to progress steadily over the medium to long term, in the short term the momentum of BEV penetration is softening, with internal combustion engine (ICE) vehicles and hybrid electric vehicles (HEVs) being reconsidered in some regions. While expediting product development and production capacity ramp-ups for BEVs, we must ensure that our product lineup and supply capacity reflect the powertrain mix required by each region at any given time. (Electrification Systems, Powertrain Systems, and Thermal Systems P.82–87)

Rising demand for in-vehicle semiconductors: By 2030, the global market for in-vehicle semiconductors is expected to be approximately 3.5 times bigger than it was in 2020. Semiconductors are becoming more important than ever due to the coming of a decarbonized society and innovations in mobility technologies.

Semiconductors also play critical roles in non-automotive industries. In the early 2020s, the COVID-19 pandemic triggered semiconductor supply issues in various industries. Transcending individual industries, a struggle for supremacy in relation to semiconductors continues as geopolitical risks emerge. To ensure a stable supply of highly competitive semiconductors, strategic technology development and the establishment of supply chain structures are essential. (Advanced Devices P.90–91)

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. As the importance of in-vehicle software grows, more IT companies are entering the automotive industry, and competition is becoming increasingly fierce not only in the development field but also with regard to standardization and commonality aimed at penetration. (Mobility Electronics P.88–89)

Intensification of labor shortages: The number of people facing food insecurity is rising due to frequent climate crises globally and disruptions in logistics and supply networks as a result of conflicts. Worldwide, there is ever-increasing demand for stable, large-scale agricultural production and the establishment of food value chains that allow everyone to enjoy the benefits of food security and safety.

In addition, labor shortages are becoming more serious around the world, especially in developed countries. A noteworthy example of this issue is Japan's "2024 logistics problem"* (shortage of truck drivers). To solve the issues that are emerging due to the decline in the working population and to enable the continuation of production activities, society must improve productivity by introducing new technologies for manufacturing and logistics networks. (Factory Automation and Social Solutions; Food Value Chain P.92–93)

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

Reweighting of Our Business Portfolio

Since fiscal 2022, DENSO has been optimizing its business portfolio to simultaneously maximize business growth and social value creation that accord with the Company's green and peace of mind principles. Our goal is to concentrate in-house management resources on fields that better align with both earnings growth and our principles. We will invest more in growth and priority businesses. As for contracting businesses, with an emphasis on discipline we will decisively implement well-focused capital expenditures and investments in R&D.

In today's cross-field pursuit of new products and value, competition is becoming ever more complex. Rather than adopting the viewpoint of a stand-alone company, we will drive industry reorganization through selection and concentration that promotes the medium- to long-term growth of the industry as a whole. With the aim of accelerating the transformation of our portfolio, we have assigned a Companywide task force to conduct both financial and non-financial verifications each year and to constantly formulate and implement partner strategies. We will continue to formulate strategies and narrow down partner candidates. Without trying to be overly self-sufficient, we will assemble an optimal lineup of businesses by forming alliances with various partners (M&As) while growing priority businesses and rightsizing or exiting from mature businesses.

Industry-wide Efforts to De-Emphasize and Discontinue Internal Combustion Engine Products

DENSO views rightsizing or exiting from mature businesses as de-emphasizing and discontinuing internal combustion engine products in a manner that allows customers, the companies assuming DENSO's businesses, suppliers, and DENSO to move toward optimal situations. Based on this policy, we have already disposed of the fuel pump module, type III alternator, and spark plug businesses. In fiscal 2024, we announced our intention to begin considering the disposal of certain ceramic product businesses. While continuing to safely and reliably offer customers products of the same high quality as a basic principle, we will create capabilities in the entire automotive market enabling the supply of products that have appealing performance and pricing.

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 automotive components. With a focus on various solutions that create value for society in the mobility field, DENSO is currently utilizing technologies accumulated in the automotive field to develop a range of businesses that will support the 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, we will conduct business activities and utilize honed technologies to help achieve the Sustainable Development Goals (SDGs), address social issues, and create new value.

	Segment	Revenue (Billions of yen)	Core Products That Contribute to Green and Peace of Mind (● Green ● Peace of mind)
Automotive businesses	Electrification Systems P.82–83	874.6 (22), 1,042.1 (23), 1,241.6 (24) (FY)	● Inverters (Power control units): Appropriately control power between the batteries and motors of BEVs and HEVs ● Motor generators: Help improve fuel efficiency as the main power sources for HEVs during driving and as generators during braking ● Battery ECUs: Control batteries safely and with high precision and help improve fuel efficiency and extend driving distance ● ESUs (Electricity supply units): Incorporate charging control, AC chargers, voltage control, etc., into one unit
	Powertrain Systems P.84–85	1,324.5 (22), 1,489.3 (23), 1,518.6 (24) (FY)	● Common rail systems and gasoline direct injectors: Realize stable combustion through optimally controlled fuel injection ● Ignition coils and spark plugs: Enable ignition and efficient combustion in gasoline engines ● Exhaust and cam timing systems: Detect oxygen concentration and adjust the opening and closing of intake and exhaust valves, etc. ● Starters and alternators: Start engines and control power generation and charging
	Thermal Systems P.86–87	1,282.0 (22), 1,585.6 (23), 1,730.8 (24) (FY)	● ● Heat exchangers: Cool and heat air and water by exchanging heat with the atmosphere ● ● Air-conditioning systems for cars (passenger and commercial): Adjust cabin temperature and airflow and boast excellent compactness, performance, ease of installation, and comfort ● Inverter cooling systems: Improve power output density by cooling power semiconductors and realize compactness and weight reduction ● ● Thermal management systems: Reduce air-conditioning energy wastage by utilizing atmospheric heat and contribute to battery life extension and rapid charging, etc., through temperature control
	Mobility Electronics P.88–89	1,356.4 (22), 1,615.5 (23), 1,941.8 (24) (FY)	● Powertrain electronic control units (ECUs): Optimally control the powertrains of gasoline vehicles, HEVs, and BEVs and contribute to carbon neutrality ● Advanced driver assistance systems (ADAS): Support safe driving by using image sensors and millimeter-wave radar to recognize the surrounding environment ● Integrated human–machine interface (HMI) systems: Provide drivers with optimal information through integrated control of multiple HMI devices ● ● Software: Software incorporated into various systems, ECUs, and sensors
	Advanced Devices P.90–91	358.3 (22), 361.6 (23), 424.0 (24) (FY)	● HEAT-PRO (Highly efficient thermal management valves for BEVs): Improve energy use efficiency by precisely controlling the cooling water of electric vehicles ● Electrical current sensors: Help improve vehicle performance by improving electric mileage, etc., through measurement of the electrical currents of batteries ● Power semiconductors: Switch strong electrical currents and high voltages on and off in inverters ● ● Application-specific integrated circuits (ASICs): Integrate a wide variety of complex in-vehicle controls in a single semiconductor
Non-automotive businesses	Factory Automation and Social Solutions P.92	186.9 (22), 176.5 (23), 144.8 (24) (FY)	● Industrial robots (Articulated and collaborative): Contribute to productivity and safety ● Internet of Things (IoT) system architecture products: Include servers, integrated software, and visualization tools for Factory-IoT (F-IoT) ● Barcode and 2D code handy terminals: Offer excellent operability as commercial code readers ● QR solution services: Create new value reflecting society's needs and befitting the manufacturer responsible for the development of the QR Code®
	Food Value Chain P.93	Note: The year-on-year decrease in revenue was due to such factors as the disposal of the cell phone sales and agency business.	● ● Greenhouses for medium-sized and large farms: Adapt to producers' needs ● ● Fully automated harvesting robot Artemy®: Fully automates the process of cherry truss tomato harvesting ● Cold chain (Compact mobile freezing and refrigeration units): Enables temperature-controlled delivery that is safe and reassuring ● ● QR traceability systems: Facilitate secure, centralized data management encompassing supply chains from producers through to consumers

Note: Amounts equivalent to revenue from semiconductors manufactured in-house for other DENSO businesses have been excluded.

Product Technologies Supporting Value Creation

DENSO's Comprehensive Strengths: Supporting Vehicle Electrification and the Evolution of Inverters

An inverter is a power converter that plays a key role in supporting the driving power of an electric vehicle. It converts the direct current from the battery into an alternating current that is supplied to and runs the motor, which in turn powers the vehicle. Enhancement of inverter performance is essential for the popularization of electric vehicles. In particular, the efficient cooling of inverters, which handle high voltages and large currents, is essential for the achievement of high power output, which indicates that an inverter is performing effectively. Moreover, efficient cooling is vital for the realization of more-compact, lower-cost inverters.

The history of DENSO's inverter development began with the establishment of the EV Project Room in 1992. After our inverters for HEVs had been adopted by several manufacturers, we decided to take up the challenge of developing an ultra-compact inverter capable of delivering three times the power output of conventional inverters of the same size. We realized a level of power output that was generally considered to be impossible at the time by using a world-first technology for double-sided layered cooling structures, which we created through the application of heat exchange technology fostered in the development of radiators. In 2004, DENSO began production of inverters. We established an original production technology by eliminating issues through more than 200 rounds of on-site inspections and swift decision-making. In 2007, DENSO started up mass production of inverters with the aforementioned revolutionary structure and brought them to market.

In the 2020s, as the worldwide trend toward vehicle electrification began gathering momentum, DENSO developed high-efficiency inverters that use silicon carbide (SiC) power semiconductors. Under certain driving conditions, these inverters reduce power loss by more than half compared with conventional inverters, which use silicon (Si) power semiconductors. Our new inverters help extend the driving distance of BEVs by increasing their electric mileage.

By tirelessly refining its technologies and *Monozukuri* capabilities and concentrating its comprehensive strengths, DENSO will continue giving people products that address social issues.

For HEVs

Double-sided cooling inverters (2007)

For BEVs

Inverters with SiC power semiconductors (2023)

DENSO Integrated Report 2024
Overview by Product

ELECTRIFICATION SYSTEMS

Popularizing vehicle electrification systems and products to lead the global carbon-neutral trend and help provide mobility that is safe, reassuring, and highly convenient

We are working to reduce the size, enhance the performance, and improve the quality of electrification products such as inverters and motor generators. In addition, we are striving to enhance system technologies such as energy management technologies, which efficiently control electricity and thermal energy, and power supply system technologies, which can optimize and safely make full use of batteries. By doing so, we will continue to improve the performance of various kinds of mobility as we work to realize a carbon-neutral society and provide safe, secure, and highly convenient mobility.

Tsuneo Maehara
Head of Business Group

Relevant SDGs

Business Strengths

Technology Development Capabilities and Product Lineup

Our basic strategy is vertical integration. At each operational level, from systems through to products and semiconductors, we establish in-house production capabilities, and the competitiveness of each operational level is further strengthened through the mutual sharing of technological know-how among the levels. Built up during more than 25 years of experience in vehicle electrification operations, our technology capabilities at each operational level are competitive. Going forward, we will expand our vertical integration to the energy management field to create further competitiveness and provide a product lineup that meets customer expectations.

Global Production and Supply System

To meet the growing demand for electric vehicle components, we have more than 50 bases in 19 countries, supplying products to customers around the world. At the Anjo Plant, which is DENSO's global mother 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 CO_2 recycling plant and an energy-saving environmental production line that curbs CO_2 emissions.

In-vehicle Reliability

Quality is becoming increasingly more important in order to reduce vehicle breakdowns. We must manage quality-related breakdowns while realizing systems that optimally integrate vehicle functions for driving, turning, stopping, and comfort. DENSO has built up expertise in the reliability of in-vehicle systems, products, and semiconductors based on experience garnered in its founding electrical equipment business and from vehicle electrification operations. We provide optimal quality by managing the stress that products are subjected to as well as the strength of products throughout entire systems.

Business Strategy

Even as the trend toward electric vehicles becomes more complex, we aim to achieve a 30% share of the electrification domain by fiscal 2031 through the development of technologies ahead of our competitors, the establishment of supply capabilities that meet customer expectations, and the provision of quality that exceeds customer expectations.

Business Portfolio Transformation	• Update on electric drive strategy: The battery electric vehicle (BEV) products that we have strengthened in recent years have been informally adopted by certain customers, proving the competitiveness of our products. The business will expand by combining BEV products with hybrid electric vehicle (HEV) products, which are one of our existing strengths, to prepare products not only for plug-in hybrid electric vehicles (PHEVs) but also for fuel-cell vehicles (FCVs) and for commercial, agricultural, and construction vehicles. Also, we will accelerate the development of future technologies, especially the development of next-generation semiconductors, to maintain our competitiveness. • Creation of a second mainstay in the power supply business: Enhancing the convenience of electric vehicle charging has already emerged as an issue. As electric vehicles become more widespread, electric vehicle power supply systems themselves will diversify, and in the age of automated driving, optimal redundant power supply systems will become even more necessary. We have been providing power supply products that operate batteries and detect and assess their status so that battery cells can be used up safely. However, by offering a complete lineup of power supply products other than battery cells, we will transform ourselves into a supplier that can propose and provide optimal battery system solutions. In this way, we will grow operations into a second mainstay of the power supply business.
Realization of Sustainability Management	Maximization of earnings from existing businesses: In the motor generator business, where automakers have a strong preference for in-house production, we will not only expand our product lineup to meet needs but also maintain strong partnerships with customers and suppliers in relation to *Monozukuri* and the creation of core technologies. Through such efforts, we will strengthen the foundations of the business. Further, we will rigorously maximize earnings in all aspects of our business activities. For example, we will convert integrated starter generators and electric power steering motors for use in compact vehicles and electric motorcycles. Also, we will utilize these products for in-plant automatic guided vehicles and autonomous mobile robots, which dramatically increase our production efficiency.
Creation of New Value	Market creation through the realization of air-cooled power conversion with high power outputs: To expand in all types of vehicle electrification markets, the business will initiate innovations that combine its advantages in the compact power domain with regard to technologies for electromechanically integrated rotating machines. By realizing air-cooled power conversion with high power outputs that surpass conventional limits, we will pursue new enhancement of mobility value.

Business Analysis Q&A

Q: What is the impact of the slowdown in the global trend toward BEVs?

A: The expansion of the BEV market has recently softened, while the HEV and PHEV market is expanding again. However, we will not change our basic strategy of strengthening our competitiveness through vertical integration that establishes in-house production capabilities for everything from systems through to products and semiconductors. Few suppliers can offer both HEV products, which have always been our strength, and BEV products, which we have bolstered in recent years. Therefore, we believe that the situation has in fact become favorable for us.

Q: How do you plan to compete with the development speed of China's market?

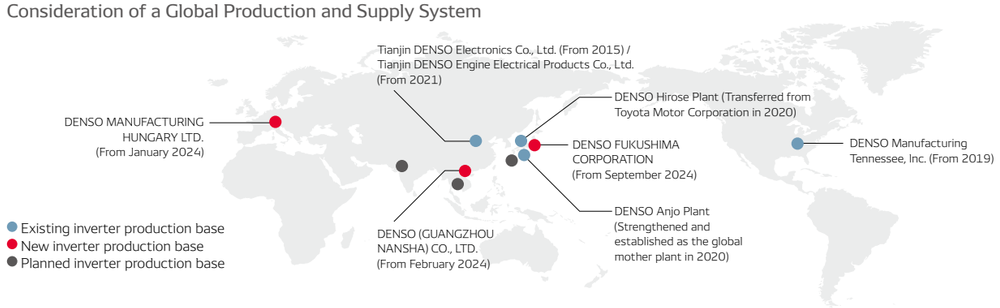
A: With respect to increasing development speed, we will continue our existing practice of giving first priority to vehicle safety and quality. With this practice as a basic premise, we will enhance development efficiency through integrated management of the advancement of all stages—from development and design through to manufacturing processes—in both the digital technology and physical technology areas. These efforts will be conducted by the Electrification Innovation Center, which has been established within the Anjo Plant. By fiscal 2026, we will halve the development lead time from product design through to mass production compared with that of fiscal 2023.

Objectives and Results of Strategies for Green and Peace of Mind

Objective: Establish a five-pole global bridge system for inverters that both meets regional demand and hedges supply risk
Results: Began additional inverter production in Europe to respond to the diversification of customer demand due to the expansion of the electrification market; followed on from the commencement of production in the north of China by starting up production at bases in the south of the country; began establishing production capabilities in India and ASEAN countries in light of customer trends and in preparation for further market expansion; and in Japan, as part of efforts to strengthen production bases near customers, began production at DENSO FUKUSHIMA CORPORATION for eastern Japan and new production in western Japan currently under consideration

Objective: Begin development of zero-carbon motors to realize net-zero CO_2 emissions throughout product life cycles
Results: Advanced the development of design technology for high torque density to achieve compactness and the development of application technology for low CO_2 materials; completed estimation of torque density potential; in fiscal 2025, will advance development prototype production by specifying elements required for high torque density designs; and will aim for an 80% reduction in CO_2 emissions

Consideration of a Global Production and Supply System



Resolving Social Issues through Our Businesses

Contributing to the Realization of a Sustainable Carbon-Neutral Society by Evolving Electrification Technologies for All Types of Vehicles and Popularizing Products

In addition to providing electrification technologies for HEVs, PHEVs, BEVs, and other passenger cars, we are developing such technologies to support all types of electric mobility, including everything from automated conveyors in plants and warehouses, compact vehicles, and two-wheeled vehicles in the domain of compact electrification, to commercial vehicles, agricultural construction equipment, and aircraft in the domain of large-scale electrification. In particular, we are developing electric motors (e-motors) for electric vertical take-off and landing (eVTOL) aircraft, which solve the issues of traffic congestion in cities and the resulting CO_2 emissions as well as the need for high-speed transportation networks that enable travel for the shortest possible distance and are connected to suburban and sparsely populated areas that are distant from trunk communication routes. By doing so, we have added to our product lineup e-motors that can be applied to two types of propulsion: propellers and jets. Our newly developed e-motors are both compact and lightweight to an extent that exceeds conventional standards, thanks to the use of lightweight materials and enhanced cooling performance.

We will apply technologies cultivated for vehicles in the automotive industry to aircraft, including electrification technologies and technologies for the mass production of high-quality products. At the same time, we will apply technologies honed in the aircraft business to the automotive industry. In this way, DENSO will contribute to the realization of a sustainable mobility society.

e-motors for eVTOL aircraft:
60% weight reduction versus conventional motors


Jet propulsion-type motor


Stator


Rotor

POWERTRAIN SYSTEMS

Balancing the joy of life with vehicles with superior environmental performance: Providing solutions that help overcome this seemingly contradictive 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.

Relevant SDGs

Hisashi Iida
Head of Business Group

Business Strengths

R&D Capabilities That Have Led the Evolution of Powertrains

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. We will apply our core technologies and development capabilities to increase the options in relation to carbon-neutral powertrains, such as hydrogen and biofuel engines.

Highly Reliable *Monozukuri* Technologies That Enable Cars to Run Safely

To enable cars to run well, DENSO has refined its highly reliable *Monozukuri* technologies, which are integrated from the stages of highly complex and precise processing at the micron-unit level, technologies for high-speed assembly, and materials preparation through to the stages of molding and sintering. We will further enhance such technologies by using our long-standing skills and *Monozukuri* expertise in combination with robots, AI, digital technologies, and other leading-edge technologies.

Personnel, Masters of Powertrains, Form Organically Coordinating Organizational Capabilities

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. Through these efforts, we have acquired additional technologies and skills. Moreover, meeting the needs of markets and customers has honed the capabilities of 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 2025 we will continue efforts to de-emphasize and discontinue internal combustion engine products throughout supply chains and to commercialize new energy businesses.

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. In this way, we will establish a profitable structure that is not premised on rising production volume and 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 management resources—personnel, products, and funding—to growth fields. We can only achieve business portfolio reweighting in partnership with customers, suppliers, and a wide range of other stakeholders. It is important to establish a consensus before initiating activities and to design procedures and conduct painstaking management that incorporates the rigorous hedging of potential risks so that in these partnerships both parties can work together without undue pressure on their resources. With this in mind, we are proceeding with activities while engaging in careful dialogue with stakeholders from as early a stage as possible. Our approach to business portfolio reweighting is designed to be optimal for customers, suppliers, and the companies that assume our businesses. We define this approach together with the development of personnel and organizations that enable the reweighting as “DENSO-style de-emphasis and discontinuation of internal combustion engine products.” We will continue our activities with a view to the completion of reweighting.
Realization of Carbon Neutrality and the Creation of New Value	Hydrogen is an important energy source for the realization of a carbon-neutral society. Moreover, hopes are very high in relation to the role that hydrogen with play in the creation of new industries. DENSO aims to utilize its existing powertrain technologies (system construction and ceramic-related technologies) to both help create a hydrogen society and achieve business growth in the system construction field, the peripheral equipment field, and various other fields in partnership with Toyota Motor Corporation, which is a leader in the use of hydrogen in mobility.

Business Analysis Q&A

Q: What is the future strategy for the powertrain systems business as the internal combustion engine business contracts? Also, what will the role of the internal combustion engine business be in the trend toward carbon neutrality?

A: Amid heightening environmental awareness, providing power sources with low environmental impact is a social issue regardless of the region. In the United States, Europe, and China, the trend toward vehicle electrification is continuing. However, the rate of progress varies greatly depending on the region. Engines powered by hydrogen, biofuels, e-fuel, and other fuels with high energy efficiency and low environmental impact are also attracting increasing attention.

In relation to internal combustion engine products, DENSO has developed advanced technologies that are highly regarded by the market. For example, we boast a 30% share of the market for internal combustion engine-related components for gasoline vehicles. We will leverage the aforementioned technologies to develop engines powered by fuels that have small environmental impacts, thereby supporting the industry as a whole as it proceeds through a transitional phase and achieving global environmental initiatives.

Objectives and Results 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: Based on regulatory and market trends, held discussions with customers and suppliers; reached a basic agreement on the future direction; began preparing scenarios; rapidly commenced efforts; ensured that customers and DENSO as well as suppliers and DENSO were in step with each other; and carefully advanced activities one company at a time

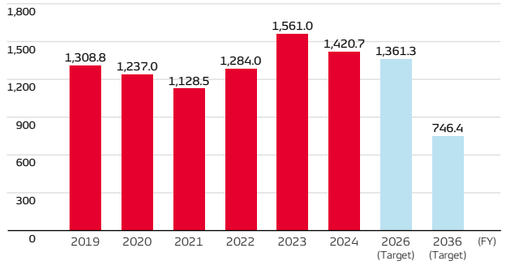
Objective: Achieve commercialization in the new energy field through alliances with related parties
Results: Through discussions with industry stakeholders, agreed on moving forward with various projects; in fiscal 2025, shifting to implementation by realizing commercialization while advancing implementation demonstration activities

Reassignment of Personnel to Maximize Created Value

In the process of contributing to the spread of vehicles by reducing environmental impact while offering convenience, we have taken on many challenges and made many mistakes, acquired numerous technologies and skills, and developed the abilities of our personnel and organization through interactions with the market and customers. By integrating the ability to construct three-pronged systems that are realized through highly robust products and electronic control and our *Monozukuri* capabilities that leverage high-precision design and manufacturing technologies with digital skills, we will transform our human resource portfolio so that it drives expansion in growth fields, bolster our organizational capabilities, and develop professionals that can realize our management philosophy.

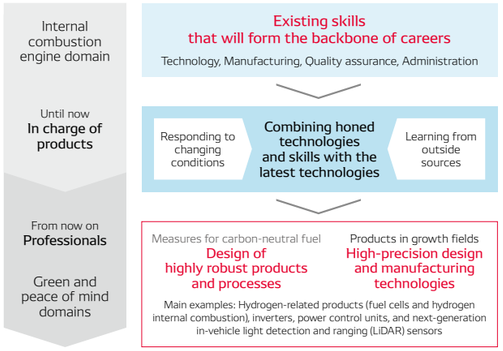
Revenue of Internal Combustion Engine Products Designated to Be De-Emphasized or Discontinued*

(Billions of yen)



* Powertrain Systems Business Group overall

Contributions of Personnel to Our Future



Resolving Social Issues through Our Businesses

Industry-wide Activities to De-Emphasize and Discontinue Internal Combustion Engine Products

We are optimizing our business portfolio to maximize green value and peace of mind value. At the same time, we have an important responsibility to continue delivering safe and reliable products to those in regions where internal combustion engines will still be needed for some time to come. If individual companies continue operating based only on their current formats, they will eventually become smaller and weaker, which could make it difficult for them to keep providing services. To avoid such a situation, ensure a long-term stable supply of internal combustion engine products, maintain competitiveness, and help accelerate commercialization in growth areas, we are de-emphasizing and discontinuing internal combustion engine products. However, we cannot achieve this on our own. Therefore, we are collaborating with automakers and suppliers to reorganize businesses with the aim of establishing a structure that can continue meeting the market’s supply needs even as production volume decreases. These collaborations include such activities as the integration of specifications, the replacement of old-model products, and the transfer of businesses. In fiscal 2025, we will continue these collaborative activities and move toward the realization of a more sustainable industry structure.

THERMAL SYSTEMS

Contributing to a more pleasant world by spreading *Monozukuri* that is based on energy management technologies and clean energy

To halt global warming, the curbing of greenhouse gas emissions is an urgent task. With a view to addressing this social issue, the Thermal Systems Business Group will build and disseminate new paradigms for cars and society by going beyond existing frameworks to advance creation with internal and external partners. In these initiatives, we will primarily use environmental technologies that we have developed for the thermal management of cars. Further, we will endeavor to realize a carbon-neutral society as soon as possible by popularizing environmentally friendly products through utilization of the advantages of our well-established global supply chain, which is deeply rooted in many different regions.

Katsuhiko Takeuchi
Head of Business Group

Relevant SDGs

Business Strengths

Numerous World-Leading Environmental Technologies

By further evolving its environmental technologies, which are underpinned by some 2,400 environmental technology patents—the largest patent group of its kind in the world—and by numerous world-first products and products that boast leading market shares, the business group will extend the scope of DENSO's technological contributions from thermal management systems to energy management systems and from cars to society as a whole.

Co-creation beyond Organizational Boundaries

In a co-creation initiative with Toyota Motor, DENSO FUKUSHIMA CORPORATION has created a carbon-neutral plant by establishing local production and local consumption of hydrogen. Through such initiatives, the Thermal Systems Business Group will continue creating and raising the profile of new business models by going beyond business group boundaries to mobilize and concentrate DENSO's technology capabilities and collaborate with customers and new partners around the world.

Global Supply Chain

At the approximately 50 bases we operate worldwide, we will help address environmental issues in each country by accurately understanding the diversifying customer demand in countries and regions and providing timely supplies of competitive products through our locally rooted supply chain.

Business Strategy

For both combustion engine and electric vehicles, we will refine our accumulated refrigerant and water-based heat exchange technologies, improve our core products, and market new products, thereby maintaining and augmenting our business foundations. In addition, with our sights set on further accelerating initiatives for the realization of a circular economy and carbon neutrality, we will advance business portfolio reweighting that includes resource reallocation. We will also move forward with ambitious initiatives aimed at addressing global warming by pursuing innovation in heat "manipulation" technologies and extending the scope of our business from people to vehicles and from there onward to society at large.

Realization of Sustainability Management	Many years of focusing on our strengths—mass production stability, global supply capabilities, and a commitment to product quality—have advanced our personnel, technologies, and products. Utilizing these fundamental strengths, in the electric vehicle age we will strengthen and stabilize our business foundations by maintaining an emphasis on high quality and stable supply as we continue to create compact, highly efficient thermal management modules and other new products and technologies.
Business Portfolio Transformation	In response to customer demand, which reflects the energy policies of respective countries, we will offer optimal solutions and contribute to the realization of carbon neutrality by rolling out our current products and innovating in new fields. To accelerate development in new fields, we will engage in dialogue with our customers and suppliers with a view to stepping up the pace of business portfolio transformation on a global, industry-wide basis. DENSO will reallocate and optimize the resources freed up by these changes so that it can boost the development and sales of environmental technology products.
Creation of New Value	At DENSO, our goal is not only to achieve progress for cars but also to create a world that reflects society's needs and is full of happiness. To realize such a future, we will further advance our proprietary environmental technologies to reduce the energy wastage of cars to as close to zero as possible. By extending the scope of these technologies and applying them to society, we will promote ambitious initiatives focused on circulating energy through the connection of cars and society and thereby addressing the energy issues facing society as a whole. Based on these initiatives, we aim to achieve the ultimate in vehicle energy conservation and global warming mitigation.

Business Analysis Q&A

Q: How will the trend toward vehicle electrification change the thermal management of vehicles?

A: To achieve carbon neutrality, which is a major objective of vehicle electrification, we must effectively utilize the waste energy from air-conditioning and electric equipment. The basis for solutions to this energy utilization issue is provided by DENSO's thermal management systems. Indispensable to electric vehicles, these systems use proprietary heat pump technology for the generation of heat with small amounts of power and control air conditioners, batteries, inverters, motors, and other electric equipment to ensure their temperatures are appropriate, thereby contributing to cabin comfort, driving safety, and the extension of driving distance.

DENSO will take on the challenge of enhancing the comprehensive management of vehicle energy with the aim of achieving a 75% reduction in the energy used for vehicle temperature control by 2030. To effectively use energy without wastage, we will realize technologies that collect and reuse heat from electric equipment. We will achieve a whole-vehicle energy management system and broaden the extent of our contributions from the sphere of cars to society at large by forming internal and external collaborations and partnerships and using our all-important insight as a manufacturer with a thorough knowledge of cars.

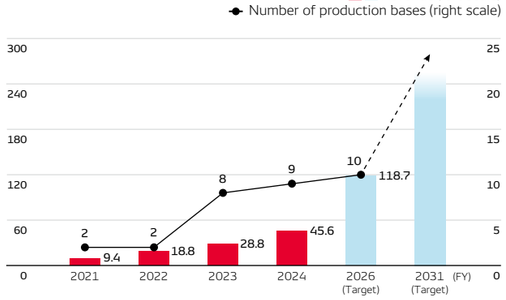
Objectives and Results of Strategies for Green and Peace of Mind

Objective: Develop a new framework to continuously benefit customers
Results: Built a framework for the continuous support of customers through the formation of partnerships and realized the transfer of the exhaust gas recirculation cooler and stainless steel oil cooler business to MARUYASU INDUSTRIES CO., LTD., which endorsed the view that the industry as a whole can continue to support customers and became our strategic partner, despite previously being our competitor in this business field

Objective: Complete conceptualization of next-generation thermal management modules incorporating differentiated technologies
Results: Worked with customers from preliminary development stages to rigorously seek ideal forms of integration, which culminated in agreements with multiple global customers on product development concepts for modules and system control

Environmental Technology Products: Revenue and Number of Production Bases

(Billions of yen)



Comprehensive Strengths That Accommodate Customers Worldwide

In line with efforts to pursue a carbon-neutral society as soon as possible, there is a growing trend toward the provision of a wider range of vehicle options to enable optimal choices to be made in light of regional circumstances, such as differences in infrastructure and regulations.

DENSO's strengths include a wide array of technologies and products accumulated over many years; local knowledge and a regionally rooted supply chain, which have resulted from the Company's global expansion; and a development system and service network capable of catering to a variety of customer needs. Taking maximum advantage of these comprehensive strengths, we will work together with our customers and advance toward the realization of a carbon-neutral society.

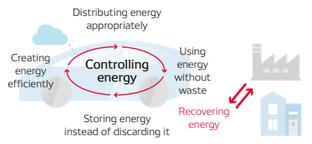
Resolving Social Issues through Our Businesses

Development of Technologies That Make Use of Waste Energy and the Realization of Energy-Neutral Temperature Control in Partnership with Society

To achieve energy-neutral temperature control—whereby the energy required for automotive air-conditioning and equipment temperature control is effectively reduced to zero—by 2035, we must establish a world where the integration of cars with infrastructure allows society to make maximum use of all available energy resources.

Currently, society is said to lose about 60% of primary energy as waste heat. The resolution of this problem calls for technology that enables waste heat to be efficiently used when and where it is needed. Tackling this issue through efforts related to the manufacture of cars, DENSO will boldly develop energy storage and thermal energy conversion technologies. Through the recovery of waste heat from vehicles and greater society, the reuse of stored heat energy for other purposes, and the conversion of heat into other forms of usable energy, these technologies will support our creation of ultimate energy-saving vehicles that make full use of energy resources without any waste.

Connecting with Society to Make Full Use of Unutilized Energy



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.

Relevant SDGs

Hiroshi Kondo
Head of Business Group

Business Strengths

Ability to Create Large-scale Integrated Systems That Connect Cars, People, and Society

The demand for electronic systems is evolving as vehicles become more intelligent due to the introduction of software-defined vehicles (SDVs) and the revolution resulting from the increased production of connected, autonomous, shared & service, and electric (CASE) vehicles. In addition to existing demand for powertrains, bodies, chassis, cockpits, advanced driver assistance systems (ADAS), and other single-domain control systems, new demand for large-scale systems that integrate and coordinate these systems is emerging. Moreover, demand is growing for systems that connect cars with the outside environment. DENSO will realize appealing products by utilizing the technological capabilities and integration capabilities that it has garnered in the course of developing a full range of the aforementioned systems.

Product Development Capabilities with Reliability and Sophistication Accumulated in Automotive Products

Automotive products must realize high levels of reliability and performance in harsh environments and under operational restrictions. We have been engaged in the automotive electronic product business for many years—ever since the early days of vehicle electrification—and accumulated extensive vehicle-related expertise as a result. By utilizing the advantages of this expertise, DENSO is developing competitive products that combine the differentiated reliability and performance of its automotive products with the latest electronics and software technologies.

Global Network

To expedite the realization of large-scale systems in the SDV era, collaboration with partners is essential. DENSO has developed human capital, intellectual capital, and a global production system by overcoming numerous obstacles in partnership with semiconductor manufacturers, software vendors, and automakers around the world. Using these strengths, we will refine our SDV-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 SDVs and battery electric vehicles (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) and the growth field of large-scale integrated ECUs. Using this shift as an opportunity, DENSO will develop and grow businesses through portfolio management that strengthens its presence in this growth field.

Creation of New Value	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. • As the value sought in relation to cars shifts from functionality toward user experience, we will bolster initiatives focused on planning products that reflect the user perspective, proposing them to customers, and creating commercial products. Through the creation of value, we will enhance profitability. • 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 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.
Business Portfolio Transformation	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.
Realization of Carbon Neutrality	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 Factory-IoT (F-IoT) to visualize energy wastage at manufacturing sites, the sourcing of recycled materials, the development of repair technologies, and the development of products with structures that facilitate disassembly.
Realization of Sustainability Management	By establishing business foundations that are adaptable to change, we will achieve sustainability management. • 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. Further, we will utilize AI technology to enhance the efficiency of development. • 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 to changing conditions.

Business Analysis Q&A

Q: From a cost perspective, how do you plan to respond to increasingly large-scale software development?

A: As we enter the SDV era, more-extensive vehicle functions and their integration with society will significantly change in-vehicle electronic platforms and greatly increase the scale of in-vehicle software. DENSO will adapt to these changes by redoubling efforts to strengthen software development capabilities and by increasing the efficiency of development through the introduction of new work processes. In strengthening development capabilities, we plan to deploy 18,000 development-related personnel by 2030, 1.5 times more than the current number. By 2030, we also aim to establish development activities that are twice as efficient as current activities through a range of measures. Specifically, we will (1) deepen collaboration with automakers even further to achieve efficient development that encompasses the creation of specifications through to integration, (2) further strengthen the cross-industry division of labor with IT vendors and other partners, (3) strengthen efforts to establish standardized, common systems-on-chips (SoCs) and middleware by utilizing expertise in semiconductors, and (4) renew development tools by using generative AI to evolve in-house tools.

Through the aforementioned initiatives, we aim to create a software business worth ¥800 billion by fiscal 2036, roughly four times its scale in fiscal 2024.

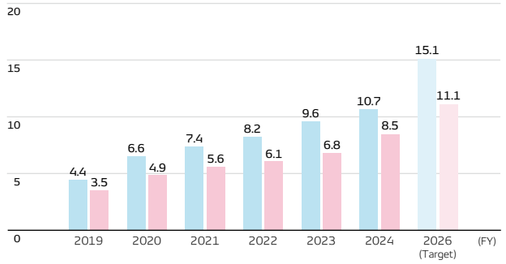
Objectives and Results of Strategies for Green and Peace of Mind

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, and increased accident scenario coverage to 37% in fiscal 2023, aiming to raise it to 56% by fiscal 2026
* GSP3: 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)



Effective in Many Different Accident Scenarios

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

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

Initiatives Aimed at the Elimination of Traffic Accident Fatalities

We believe that to eliminate traffic accident fatalities, increasing the accident scenarios for which advanced driver assistance systems (ADAS) are effective and promoting their widespread use is important. Aiming to realize a system that is effective in 100% of accident scenarios by fiscal 2036, DENSO will develop advanced technologies that combine the respective benefits of ADAS functions, human–machine interface (HMI), and infrastructure linkage. As for promoting the widespread use of ADAS, we will enhance our lineup of sensor and system packages optimized to meet the diverse needs of each region and customer. (Peace of Mind Strategy P.40–41) To realize our 2035 goal, we are also developing large-scale electronic control units (ECUs) that can process huge amounts of data at high speed. DENSO will continue developing advanced technologies and its product lineup with the aim of realizing a society where everyone can enjoy unrestricted mobility with peace of mind.

Example of a Large-scale ECU
This ECU aggregates information from sensors that monitor the vehicle's surroundings and controls the vehicle accordingly. The ECU recognizes each sensor's real-time information and is able to process it in milliseconds.

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.

Relevant SDGs

Eiichi Kurokawa
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.

Robust Semiconductor Supply Capabilities Based on In-house and Consignment Production and Partnerships

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.

Bold Pursuit of Work Grounded in the DENSO Philosophy	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	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. 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. We aim to establish multiple businesses in such areas as electric drives, human–machine interface, 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.

DENSO Integrated Report 2024
Overview by Product

Business Analysis Q&A

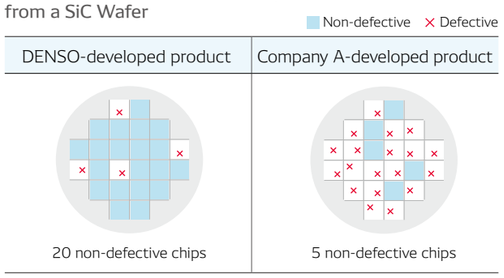
Q: Why is DENSO promoting in-house production in the field of semiconductors, where technology is evolving rapidly? Also, are there any fields in which you intend to strengthen your relationships with other companies?

A: As environmental regulations become stricter worldwide and vehicle electrification progresses, inverters with silicon carbide (SiC) semiconductors, which have lower power loss, higher quality, and larger areas, have a significant advantage in the electric vehicle market. DENSO will produce differentiated SiC semiconductors by using its proprietary "gas method" manufacturing technology, which is 15 times faster and 30% less costly than conventional manufacturing methods.

In addition, to ensure stable procurement of semiconductors in the medium to long term and strengthen our supply capacity, we are working on in-house production and alliances with partners. As part of these efforts, we are considering even further alliances. For example, in fiscal 2024 we decided to invest $500 million in the U.S.-based Coherent Corp.

By developing high-quality, low-cost technologies in-house and collaborating with optimal partners, we are maximizing our competitiveness.

Rendering of the Number of Chips Removable from a SiC Wafer

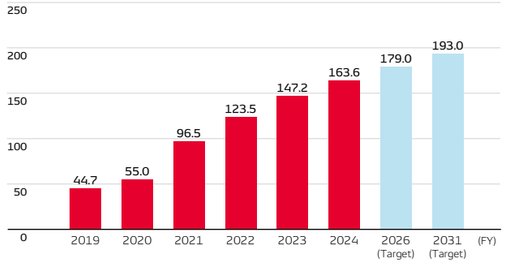


Objectives and Results of Strategies for Green and Peace of Mind

Objective: Accelerate the vertically integrated development of power semiconductors
Results: Amid an in-vehicle semiconductor market that is likely to increase 3.5 times in size between 2020 to 2030, as a Tier 1 company, supported the evolution of vehicles by strengthening fundamental technologies for semiconductors; anticipating the progress of BEVs, particularly in the electrification field, accelerated the introduction of SiC power semiconductors, which help enhance electric mileage; and, through the optimization of in-house production and alliances, vertically integrated SiC wafers, epitaxial wafers, and devices, thereby realizing lower loss, fewer defects, and greater speed and helping customers enhance product competitiveness

Unit Production of Power Card Devices

(Millions of chips)



Helping Extend BEV Driving Distances

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.

Resolving Social Issues through Our Businesses

Addressing Labor Shortages through the Commencement of a Verification Test of In-plant Automated Conveyance (Telemotion) Enabled by Sensing Technology

We are creating new solutions by connecting core sensing and actuation technologies that we have developed in the automotive field. For example, mindful of the shortage of workers due to an aging population, we are developing systems that help automate the in-plant conveyance of products. In-house, we have developed a highly accurate and reliable light detection and ranging (LiDAR) sensor that detects the three-dimensional shape of objects. Through very precise detection and recognition of transportation routes and obstacles in plants, our three-dimensional LiDAR sensor will help automate object conveyance normally performed by humans, offset the shortage of plant workers, avoid the need for long working hours, and enhance productivity. We have already begun verification tests of a conveyance system in collaboration with Toyota Motor Corporation.

FACTORY AUTOMATION AND SOCIAL SOLUTIONS

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.

Relevant SDGs

Jiro Ebihara
Head of FA Business Development Division

Business Strengths

Production Assets That Have Been Rigorously Honed in Frontline Manufacturing Operations

Using our high-quality, highly durable facilities that have been refined on auto part production lines, as well as our core factory automation (FA) 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 Expertise Garnered Over 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.

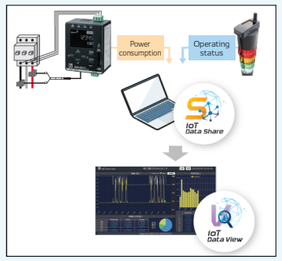
Solutions for Society Using QR Codes® Developed by DENSO

Three decades ago, DENSO applied for and registered QR Code® patents. By utilizing our longstanding expertise in QR Code® reader technologies and QR Codes® while incorporating outside ideas, we will continue creating value for new fields and applications.

Resolving Social Issues through Our Businesses

Using IoT Technology to Help Industry and Society Grow Sustainably

To promote the spread of IoT not only in the manufacturing industry but also in such diverse fields as retail, agriculture, and medicine, DENSO is participating in the development of ORiN, an international standard for smart factories that originated in Japan. As part of this effort, we have developed and marketed a package that monitors the power consumption of equipment to help enhance energy consumption in the manufacturing industry. This package can be readily used and managed with existing equipment and other companies' equipment. We will actively grow sales to contribute to the penetration of environmentally friendly manufacturing.



IoT technology-enabled solution for plants

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

DENSO offers various solutions utilizing QR Codes® with the aim of creating a society where everyone can live with peace of mind. In Kariya, Aichi Prefecture, we have conducted a verification test of a school attendance management system that contributes to child safety, while in Hiroshima Prefecture we provide a management system for the mobilization of municipal personnel that facilitates workstyle reform. In addition, as the company that created QR Codes®, we are playing a role in enhancing safety in society. For example, we have developed a special QR Code® (tQR®) that makes it possible for QR codes® to be read even when there are changes in sunlight, thereby contributing to the introduction of automatic platform gates on all Toei Subway lines. Moreover, this QR Code® was subsequently adopted by railway operators in a number of regions.

The tQR® automatic platform gate system

Contributing to a Healthy, Sound Society with Our Automated Cafeteria Checkout System

Cafeterias are owned and operated by many different companies and organizations. Through the application of the rigorously site-focused approach that it has fostered in the automotive industry and the utilization of automatic recognition technology, DENSO developed an automated checkout system for cafeterias, which was launched in 1998. Since then, we have been marketing this system, which is high speed, reliable, and user friendly and records the contents of meals using tags attached to dishes and accepts payment via employee ID cards and other IC cards. In 2024, we began offering a cloud computing-enabled system. The new system will help create a healthy, sound society by offering services that meet society's current needs, such as the promotion of health and productivity management through the provision of nutrient intake information and the reduction of food wastage through prediction of the number of meals required and digital menu displays that dispense with the need for meal samples. Other benefits of our system include efficient management for cafeteria operators and convenience for users.

Automated cafeteria checkout system

FOOD VALUE CHAIN

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.

Relevant SDGs

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

By utilizing thermal control technologies developed for automobiles, we have created compact, light versions of conventional automotive freezer/refrigerators. These portable battery-powered products allow non-specialized drivers with passenger cars to flexibly deliver a range of small-lot items. Our freezer/refrigerators do not use engines or dry ice for freezing or refrigeration, which reduces CO_2 emissions.

New Distribution DX Solutions That Reflect Changing Needs in Food Distribution

By utilizing QR Code® and RFID technologies developed in frontline manufacturing operations, we have created a fully integrated food distribution platform that digitizes a range of different food-related information. The platform caters to consumer demand for safety and reassurance with respect to food by visualizing food distribution information from production through to sale and facilitates supply–demand optimization in distribution operations and the rightsizing of inventories.

Resolving Social Issues through Our Businesses

Stabilizing Food Production by Introducing Industrial Approaches to Agriculture

In response to the food shortages and instability in agricultural production due to climate change and a global decline in farming populations, we will utilize our vehicle *Monozukuri* technologies for horticultural facilities to enable anyone to realize stable agricultural production in any location and at any time. Specifically, DENSO is working closely with Group company Certhon Build B.V., which is based in the Netherlands and possesses leading-edge horticultural facility technologies. Through highly efficient greenhouses—which combine our automation, environment control, and digital transformation technologies—and the fully automated cherry truss tomato harvesting robot Artemy,® we will introduce industrial approaches to agriculture, thereby helping to address social issues.

Greenhouses for medium-sized and large farms

The fully automated cherry truss tomato harvesting robot Artemy®

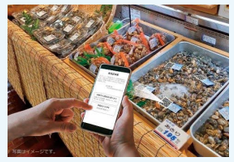
Enabling Local Production for Local Consumption and Increasing Transportation Efficiency through Temperature-Controlled Logistics between "Road Stations" and for Markets

Based on a comprehensive partnership agreement with Kumamoto Prefecture, we are conducting verification tests of portable compact freezer/refrigerators. By enabling the storage of fresh food products and their transportation between "road stations" (the distribution bases nearest stores), the model will solve the problems of opportunity losses due to insufficient stocks of fresh food products, waste due to surplus stocks, and waste and inefficiency resulting from non-temperature-controlled collection and delivery between producers and markets. As a result, the model will encourage local production for local consumption, reduce food wastage, and increase the efficiency of transportation.

Portable compact freezer/refrigerator

Increasing Operational Efficiency and Enhancing Product Branding through the Visualization of Food Distribution Data

We are contributing to the rationalization of food distribution and safety and peace of mind in relation to food through a system that uses a QR Code® to visualize food distribution data. In wholesale markets for fresh fruits and vegetables, which have concentrations of products and data, we will encourage operational and distribution efficiency by visualizing and linking data. Focusing on these markets, we will promote the widespread use of the system in the supply chain extending from producers to retailers. In addition, through a production region certification system that guarantees traceability from production to sales, we have been working to solve the problem of the intentional mislabeling of short-necked asari clams to falsely show Kumamoto Prefecture as their production region. We will roll out this system for other fishery resources by participating in national projects from their conceptual stages.



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

Special Feature: Value Creation in Action

DENSO Integrated Report 2024
Overview by Product

Contributing to Decarbonization with Technologies Accumulated in Automotive Systems Development

Aiming to Realize a Hydrogen Society: The Key to Carbon Neutrality

The world is moving toward a carbon-neutral society, and the utilization of hydrogen is key to achieving this goal. Leveraging the technologies honed through its automotive systems development, DENSO is actively engaged in the development of technologies in the areas of hydrogen production and utilization. In this section, we describe how DENSO is taking on the challenge of creating new value by contributing to decarbonization through hydrogen-related businesses.

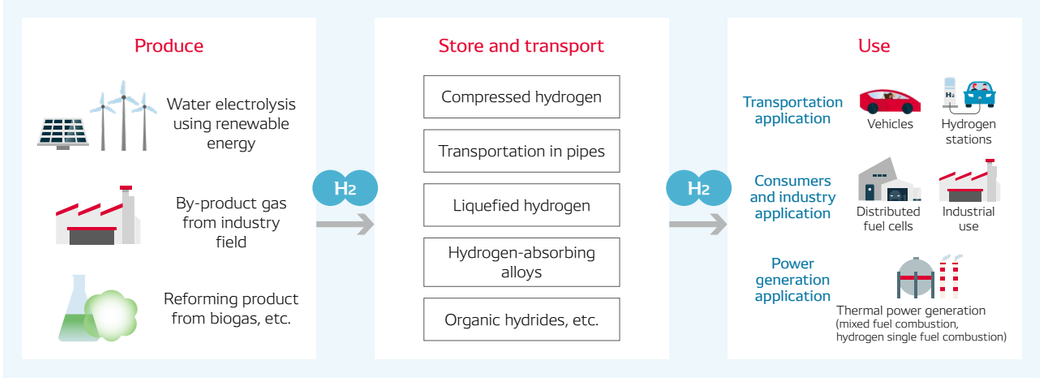
Addressing climate change is an urgent issue for humanity, and carbon neutrality is gaining momentum in the international community. To protect the environment of our planet while ensuring a comfortable and sustainable lifestyle, the world is undergoing an energy transition from fossil fuels, such as oil and coal, to cleaner energy sources. Hydrogen has been gaining attention as one of these clean energy sources.

Hydrogen is a clean source of energy that does not emit CO_2 when used as energy. Moreover, it can be extracted from various substances, including water, which is found everywhere. If the utilization of hydrogen increases, it will open pathways to decarbonization for facilities that cannot easily be electrified, such as thermal power plants reliant on fossil fuels, and large commercial vehicles such as trucks and buses, which are harder to electrify than passenger cars.

Additionally, hydrogen can be stored, a notable advantage. By converting excess electricity from renewable energy sources like solar power into hydrogen, long-term energy storage becomes feasible. In countries with low energy self-sufficiency, such as Japan, the use of hydrogen is expected to contribute not only to decarbonization but also to energy security.

However, there are still numerous challenges that must be overcome before hydrogen can be widely utilized. Various technical issues must be solved within the supply chain, such as the production, storage, transportation, and utilization of hydrogen. Efficiently producing green hydrogen* from renewable energy, ensuring its proper transport, and expanding the scope of hydrogen utilization to increase demand are crucial steps for promoting the widespread use of hydrogen.

* Green hydrogen: Hydrogen produced using renewable energy, which does not emit CO_2 during the production process, making it the most effective for decarbonization



Leveraging Our Technologies Accumulated in Automotive Development to Tackle Challenges in Hydrogen Production and Utilization

To promote the widespread use of hydrogen, it is crucial to address technical challenges related to its utilization, particularly in fuel cells and furnaces, as well as in its production, such as the water electrolysis systems needed to produce hydrogen. The key challenges that have emerged in these areas are improving the efficiency and durability of these systems.

Interestingly, these technical challenges share points in common with requirements in automotive systems. DENSO is applying the automotive technologies it has developed over the years to tackle these challenges in hydrogen.

The first challenge, efficiency, is crucial because it helps lower the cost of hydrogen utilization by ensuring that valuable renewable energy is used efficiently to produce hydrogen and also ensuring that this hydrogen is utilized without any waste.

Through its development of automotive products and technologies, DENSO has accumulated expertise in technologies for efficiently using energy in order to improve fuel economy. This includes thermal management technologies that eliminate energy waste, electrical control technologies derived from electrically powered products, and materials technologies that maximize performance. These technologies can be applied to improve the electrolysis efficiency of water electrolysis systems used in hydrogen production and to enhance the power generation efficiency of fuel cells used in hydrogen utilization.

The second challenge, durability, is essential because, regardless of how efficient or high-performing a hydrogen production or utilization system may be, it cannot be widely used if it frequently breaks down or has poor maintainability, leading to reduced operational uptime. Durability ensures that such systems can be used safely over long periods of time.

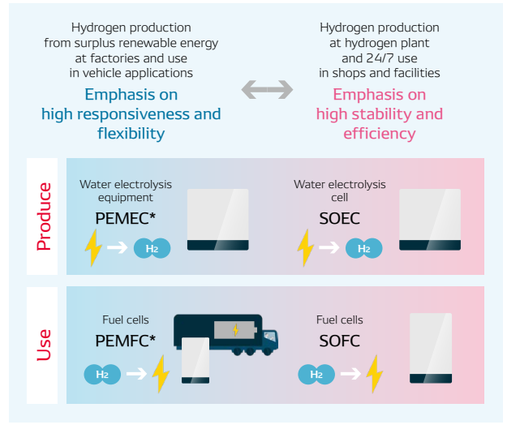
In the automotive field, vehicles must be driven safely in various environments, necessitating high durability. Through its development of automotive products refined over many years, DENSO has achieved robust levels of safety and quality that enable vehicles to operate reliably under extreme temperatures, weather conditions, and road surfaces. Additionally, the Company has established the manufacturing technologies needed to deliver these products to customers around the world. DENSO applies sensing technologies, originally developed for advanced driver assistance systems (ADAS), to constantly monitor the operations of hydrogen production and utilization systems, with the aim of ensuring that they can be safely and reliably used over long periods of time.

Providing Diverse Solutions for Hydrogen Production and Utilization to Realize a Hydrogen Society

The utilization of hydrogen remains an area filled with uncertainties, requiring various experiments to determine what solutions are the best. In collaboration with Toyota Motor Corporation, DENSO FUKUSHIMA CORPORATION is conducting demonstrations at one of its plants aimed at achieving carbon neutrality in manufacturing. In March 2024, hydrogen produced at the plant began being used in the manufacturing process for radiators delivered to customers, advancing our efforts to utilize hydrogen. In addition, DENSO is developing solid oxide electrolysis cell (SOEC) systems for producing hydrogen from electricity and solid oxide fuel cell (SOFC) systems for generating electricity from hydrogen. DENSO's manufacturing sites are conducting proof-of-concept testing of these systems.

The hydrogen supply chain has varying technical requirements at each stage. Some stages demand flexibility while others require stability. In some scenarios, small-scale decentralized systems are necessary, while in others, large-scale centralized systems are more appropriate.

DENSO is expanding its lineup of systems to meet these diverse needs. For example, the Company is developing an SOEC water electrolysis system that features a modular structure, allowing it to scale from small to large applications. These systems can be combined and configured to provide optimal solutions for specific use requirements.



* Proton exchange membrane electrolysis cell/Proton exchange membrane fuel cell. Joint development by the Toyota Group

DENSO FUKUSHIMA CORPORATION's water electrolysis system demonstration facility

DENSO CORPORATION's SOEC demonstration facility, Hirose Plant

Envisioning a Carbon-Neutral Circular Society

DENSO is expanding the scope of the challenges it undertakes, which started in the mobility domain, to manufacturing plants and other industrial domains, with an eye on creating a society where hydrogen is widely utilized. Through these demonstrations, we aim to enhance the efficiency and durability of hydrogen production and utilization systems. By applying the manufacturing techniques we honed in the automotive industry to realize high quality while lowering costs, we are beginning to see the pathway to overcoming the primary obstacle to widespread hydrogen utilization—reducing the cost of green hydrogen.

For instance, if we can synthesize methane using affordable green hydrogen, it could be supplied as a replacement for currently used city gas on a broad scale. Similarly, if we can synthesize substances like methanol, ethanol, and propane, we can decarbonize various plastic products and fuels used in our daily lives. Moreover, by combining this with carbon recycling technologies, which capture and reuse the CO_2 emitted during the combustion of these products and fuels, it is possible to realize a circular society that does not rely on fossil fuels.

The utilization of hydrogen is indispensable for achieving a circular society that efficiently uses renewable energy without waste. DENSO shares this vision with various partners across different domains, working closely together in co-creation initiatives to ensure that hydrogen is properly utilized and to guide society toward a future of decarbonization without undue burden.