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 CO_2 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 CO_2 recycling plant and an energy-saving environmental production line that curbs CO_2 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 gxB02, 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 *Monozukuri* 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 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.

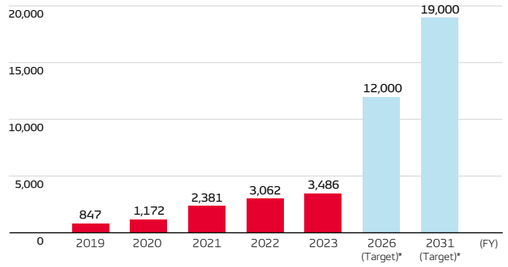
Outcome of Strategies for "Green" and "Peace of Mind"

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

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

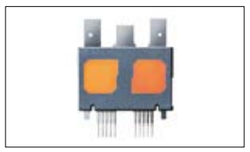
We have developed and launched an inverter that utilizes SiC power semiconductors. This inverter is used in the new LEXUS RZ, released in March 2023 as the first dedicated BEV model. Our product has been incorporated into the eAxle, an electric driving module developed by BluE Nexus Corporation.

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