

Special Feature: Value Creation in Action

Paving the Way for a Circular Economy in Mobility through
DENSO Technologies

With the intensifying environmental issues and restraints on resources occurring across the globe, DENSO recognizes that the transition to a circular economy has become a pressing global issue. In response to this, we are applying our long-cultivated robotics technologies to the vehicle dismantling process and, together with our partner companies, are building a value chain for the automotive industry integrating manufacturing and recycling. Through these efforts, we aim to realize horizontal car-to-car recycling, in which materials collected from dismantled vehicles are regenerated into raw materials and once again used in the production of new cars.

Automobiles can truly be considered as a treasure trove of resources, from the steel and aluminum used in the car body to the high-performance plastics utilized in the frame, among other scarce resources. For this reason, promoting a circular economy in the mobility domain has the potential to make a major impact on society. With that said, the complex structures of end-of-life vehicles (ELVs)* and the wide variety of materials contained therein have presented significant obstacles, and as a result, ELV recycling has been limited to downcycling, where materials are used in products with lower quality standards than the original product, and thermal recycling, in which materials are incinerated for heat. Progress toward realizing horizontal recycling has therefore been sluggish. Conventional methods of ELV recycling, which involve manual dismantling followed by vehicle shredding and material sorting, had inherent limitations in terms of material purity, and materials generated from this process could not meet the stringent quality requirements of automotive materials, which are crucial to people's safety. For example, nearly 70% of resins used in vehicles are incinerated through conventional methods, without being used, and only around 2% are reused as materials for new vehicles.

* ELVs: Vehicles that have reached the end of their service life and are dismantled after formal deregistration procedures

Assessing the Changes in the External Environment
for Realizing a Circular Economy

Amid the obstacles facing ELV recycling, policy momentum toward a circular economy has been accelerating. In the European Union (EU), progress is being made with discussion on revising regulations for ELVs. In June 2025, the EU set mandatory targets for recycled plastic content in new vehicles, and discussions are ongoing regarding the further establishment of targets for materials such as steel and aluminum in the future. In Japan, similar initiatives toward a circular economy are also gaining traction, such as the establishment of the Ministerial Council on the Circular Economy by the Cabinet Secretariat and the Circular Partners initiative, which aims to realize a circular economy through industry-academia-government collaboration by the Ministry of Economy, Trade and Industry. As nationwide strategies such as these become more concrete, there has been growing interest in achieving vehicle resource recycling in the mobility domain.

To eliminate automotive resource waste and realize resource recycling, we are working to establish an automated precision dismantling system, which was previously considered to be too difficult to achieve. This process will make it possible to recover nearly 90% of a vehicle's weight as raw materials that can be

utilized in the manufacture of a new vehicle. In this way, we are taking on the challenge of commercializing a car-to-car circular economy. Through these efforts, we aim to reduce CO₂ emissions by approximately 630 kg per ELV.

Accelerating the Recycling of Vehicles through an
Automated Precision Dismantling System

The manual dismantling of ELVs is impractical due to their complex structure and the large amount of time required. Accordingly, mechanization is needed in this process. However, due to the diversity of vehicle models and the vast number of their components, up to 30,000 parts in a single vehicle, it has been extremely difficult to mechanize the seemingly infinite number of combinations involved in the dismantling process.

Our robotic expertise provides the key to resolving this issue. DENSO possesses the ability to develop advanced robotic systems that integrate precise motion control, AI-based recognition and decision-making, and sensor technologies. Drawing on this ability, we are applying our advanced techniques for turning precise tasks done by people into standardized know-how, which we have also been putting to use in our surgery support technologies. By extracting the know-how and decision-making processes of skilled workers during vehicle dismantling and converting them into data, we will translate this expertise into algorithms that robots can execute. In addition, through collaboration with partner companies, we are taking concrete action to realize vehicle recycling through three steps: 1) vehicle shredding and dismantling, 2) component disassembly, and 3) material separation.

1. Vehicle Shredding and Dismantling

Vehicle shredding is the first part of the process for recycling ELVs. In this stage, vehicles are cut at designated points to ensure that robots can perform repetitive tasks efficiently across a wide range of car models. In addition, by attaching standardized attachment jigs to the sections of the vehicles that have been cut off, we are able to realize highly efficient robot operations and achieve dramatic productivity improvements.

2. Component Disassembly

Each component of ELVs differs in shape and degree of wear. By recording the conditions of each component, accumulating this data as big data, and leveraging it in AI learning, we will build a dismantling system capable of accurately responding to component variations. We will also further enhance dismantling efficiency through the use of digital twin technology, which transmits dismantling data collected in the real world to a virtual environment for real-time simulation.

3. Material Separation

When disassembly via robots cannot achieve full material separation, we carry out additional processing. The separated materials are then carefully inspected by material type, tagged with traceability information, and shipped.

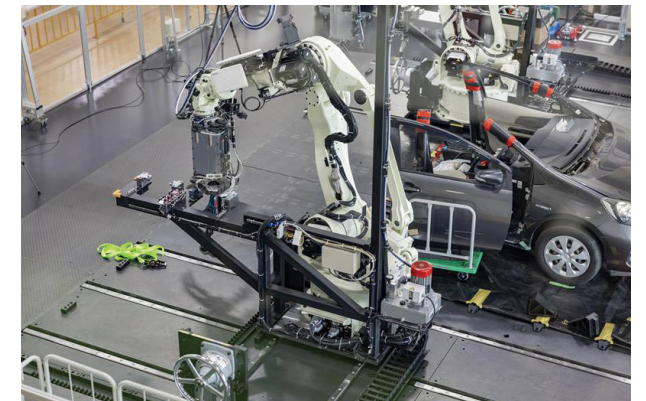
DENSO is striving to bolster its business foundation with the aim of automating key work processes by the end of fiscal 2028, while working to implement and promote the widespread adoption of its automated precision dismantling system.

Building a Sustainable Ecosystem through the
Integration of Manufacturing and Recycling
Industries

To realize a car-to-car circular economy centered on automated precision dismantling and achieve sustainable ecosystems, it is essential to establish a robust value chain through collaboration across the entire industry, including not only solutions providers such as DENSO but also renewable material manufacturers, material and component suppliers, and vehicle manufacturers.

To that end, DENSO established the BlueRebirth Council together with five other companies in June 2025 with the aim of discussing issues related to realizing an integrated manufacturing and recycling car-to-car value chain centered on automated precision dismantling (system design, example creation, maximization of synergies with other industries, advertising activities, and public consensus building) and resolving such issues through specific investigation activities, technological development, and verification efforts.

BlueRebirth is a collaborative research institution comprising dozens of major players in the Japanese mobility domain. In addition to integrating the manufacturing and recycling industries—two industries that have not sufficiently collaborated to date—BlueRebirth will tackle challenges faced by the entire automobile recycling industry, including promoting automation and digitalization and addressing worker shortages by improving workplace environments. Drawing on DENSO's automated precision dismantling system and data platforms, BlueRebirth aims to standardize dismantling processes that can respond to various ELVs and automate complex tasks. By doing so, BlueRebirth will realize an integrated manufacturing and recycling value chain.



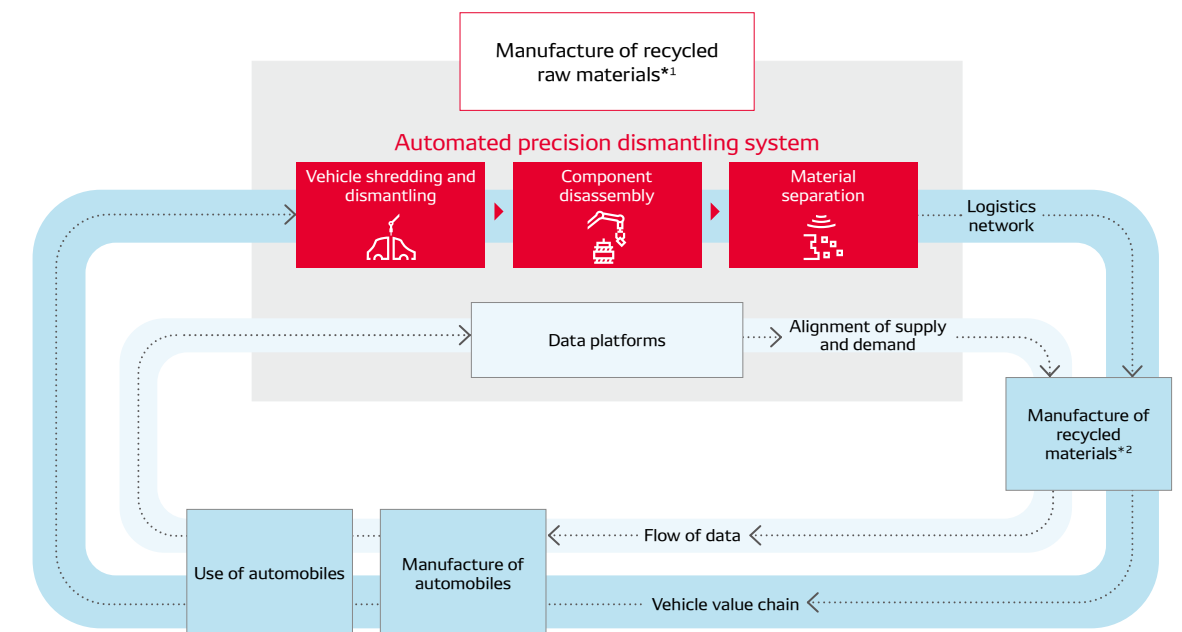
DENSO's robotics technologies underpinning automated precision dismantling system

While our endeavors have just begun, we are beginning to see a path toward the stable acquisition of high-quality recycled materials emerge through the realization of automated dismantling utilizing our accumulated dismantling know-how and robotic technologies. At the moment, we are working on prototyping new vehicles that make use of recycled materials recovered from the dismantling process, and this effort marks a significant first step toward realizing a car-to-car recycling society. Moving ahead, DENSO will fully leverage the strengths of its long-cultivated robotics, AI, and sensor technologies to take on the challenge of realizing a sustainable society together with a broad range of business partners.

For more information on BlueRebirth, please see the following website (Japanese only).
<https://www.blurebirth.jp/>



Cycle of Vehicle Recycling



*1 The process of extracting recyclable materials from used vehicles

*2 The process of manufacturing new vehicle materials from each type of recycled material