

CIRCULAR ECONOMY

The image features a dark green background with a complex, low-poly geometric pattern. In the center, there is a cluster of 3D green cubes of various sizes, some solid and some rendered as white wireframes. The wireframe cubes are scattered around the solid ones, some appearing to be in motion or disassembling. The overall aesthetic is modern and architectural.

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STRENGTHENING THE CIRCULAR ECONOMY

The finite nature of natural resources and the social and environmental consequences of mining raw materials make uncoupling economic growth from resource consumption and the development of a circular economy key sustainability topics. Against this background, businesses such as the Volkswagen Group face tighter legal regulation and increasing pressure from their stakeholders' expectations. They also recognize extensive opportunities to tap into new business models and markets or to give themselves an edge in the competition for limited resources with changed use concepts.

The Volkswagen Group created concepts for the reconditioning and recycling of vehicle components early on. One important driver of the circular economy is the ongoing decarbonization of the Volkswagen Group. The growing use of secondary materials and the establishment of closed loops of materials help to significantly reduce our CO₂ emissions.

In the NEW AUTO Group strategy, the circular economy has been defined as a focus topic within the central Group initiatives on sustainability. In the strategic design of this action area, we orient ourselves on the existing "goTOzero" mission statement. With this the Volkswagen Group is setting itself the target of, among other things, further improving its resource efficiency and promoting reuse and recycling approaches in the areas of materials, energy and water.

 > Environmental Management

MANAGEMENT APPROACH TO THE CIRCULAR ECONOMY

We want to intensify our efforts for a transition to a loop-oriented and resource-conserving way of doing business and to combine our projects and measures into a holistic approach. On the way to this, we are in close communication with our stakeholders and also with legislators and actors in politics and society. We also rely on alliances and the implementation of joint projects with various partners, such as suppliers, plant manufacturers or the recycling sector.

Circular economy is a key issue in Group Initiative 6 of the "NEW AUTO – Mobility for Generations to Come" Group strategy. Oliver Blume, member of the Board of Management of Volkswagen AG, "Sport & Luxury" brand group, and Dr. Manfred Döss, member of the Board of Management responsible for Integrity and Legal Affairs, are responsible for Group Initiative 6 as the Board tandem. We are currently in the process of putting the objectives in concrete terms. The Volkswagen Group is planning to add further KPIs that indicate progress in the area of the circular economy to the existing KPIs (DCI, reduction of the environmental impact of production). The most important measures that we want to take to implement the circular-economy strategy include further clarifying targets and indicators and also realizing circular

business models for the most important components and materials, such as batteries, steel, aluminum or plastics.

We are currently developing our own working structure at Group level for managing the activities. This builds on the work of committees such as the Group Steering Committee for the Environment and Energy, the Group Steering Committee for Sustainability, the Group Steering Committee for Product Recycling and the Group Working Committee for Environment Product. In terms of measures, in production we focus on creating the most closed material loops possible with innovative recycling approaches and on using renewable raw materials and materials produced with low emissions.

OUR GOAL: CLOSED MATERIAL LOOPS

We are stepping up efforts to use material loops in our production processes. When selecting raw materials, we opt for recycled ones obtained from production waste or end-of-life products. When developing new vehicles, we pay attention to the recyclability of the required materials, using high-quality recycled material and avoiding pollutants. Under the European Directive on end-of-life vehicles, passenger cars and light commercial vehicles must be 85% recyclable and 95% recoverable at end of life. All our vehicles registered in Europe comply with these standards.

Aluminum Closed Loop at Audi

The Aluminum Closed Loop Project, with which a closed loop for aluminum was achieved beyond Company boundaries for the first time in the Neckarsulm plant in 2017, is an example of our approach. The waste from aluminum sheet-metal parts from the press shop is delivered directly back to the suppliers, who can recycle the scrap and use it to produce new material that Audi then uses again in the press shop. Compared with using primary aluminum, recycling aluminum waste can save up to 95% of the energy used in manufacturing. In this way, Audi avoids CO₂ emissions and reduces the quantity of primary raw materials needed. In addition to the plant in Neckarsulm, the Audi plants in Ingolstadt and Győr have now also joined the Aluminum Closed Loop process. The process itself and the resultant CO₂ savings of more than 720,000 metric tons of CO₂ since 2017 have been verified by independent third parties.

In-House Expertise in Battery Recycling

Volkswagen Group Components opened the Group's first facility for recycling high-voltage vehicle batteries at the Salzgitter site at the start of 2021. The objective is industrialized recovery of valuable raw materials such as lithium, nickel, manganese and cobalt in a closed loop and also of aluminum, copper and plastic, with a recycling rate of more than 90% in the future. Batteries are only recycled if they can no longer be used in other ways – for example, in reconditioned form in mobile energy storage systems such as flexible fast charging stations or charging robots. The facility has been initially designed to recycle up to 3,600 battery systems per year in pilot operation.

The innovative and CO₂-saving recycling process does not require energy-intensive melting in a blast furnace. The used battery systems are delivered, deep discharged, and dismantled. The individual parts are ground into granules in the shredder and then dried. In addition to aluminum, copper and plastics, the process mainly yields valuable “black powder” containing lithium, nickel, manganese, cobalt, and graphite, which are important raw materials for batteries. The separation and processing of the individual substances by hydrometallurgical processes – using water and chemical agents – is subsequently carried out by specialized partners. As a consequence, essential components of old battery cells can be used to produce new cathode material. The material recovered can be used to support battery cell production in the future. The CO₂ savings are calculated to be approximately 1.3 metric tons per 62-KWh battery manufactured using cathodes made from recycled material and green electricity. That is more CO₂ emissions than are generated during the production and logistics processes of a new ID.3.

Tapping the Potential of Chemical Waste Management

Numerous components in cars are made of plastics. Quality requirements mean that up to now, these can only be made from petroleum-based materials and usually cannot be recycled. This is because recycling of mixed plastic waste poses a major challenge, while plastics of the same type can often be mechanically recycled. Audi and the Karlsruhe Institute of Technology (KIT) have therefore set up a pilot project for chemical recycling as part of the Industrial Resource Strategies THINKTANK in order to feed such mixed plastic fractions back into a resource-conserving circular system. The plastic components are processed into pyrolysis oil by chemical recycling. This oil is of equivalent quality to petroleum products, and materials made from it are just as high quality as virgin material. In the medium term, components made from pyrolysis oil can be used again in automobiles and thus increase the proportion of sustainably manufactured components in cars.

Moreover, in the “SyKuRA” project (systematic recycling of plastics from end-of-life vehicles) Volkswagen is working on feeding the plastic components from shredder residues from end-of-life vehicles into high-quality recycling. Here, too, in addition to improved sourcing technology, it is essential to explore the possibilities of chemical recycling in the form of pyrolysis for fractions that are not mechanically recyclable. In addition to Volkswagen, the Öko-Institut, the chemical company BASF, processing specialist SICON, and the Clausthal University of Technology are also involved in the project, which is supported by the Federal Ministry of Research.

Recycling Production Waste

Any waste with recyclable content generated in production is also always systematically included in our closed-loop processes. For example, in the Volkswagen Group Components foundry in Kassel, all aluminum chips generated on the site are returned to the casting process. Around 20 metric tons of aluminum chips are produced here each day and melted down in the plant.

According to forecasts, this alternative to regular aluminum production reduces the energy requirements by around 3,250 MWh per year and reduces CO₂ emissions by more than 1,400 metric tons per year. In the medium term, the foundry wants to melt down a further 40 metric tons of material from other European Volkswagen plants per day. In the long term, the quantity is set to rise to up to 80 metric tons of chips per day.

At the Volkswagen plant in Wolfsburg, plastic waste produced in the process of manufacturing tanks will in the future be prepared and used again for the production of tanks. As a result, around 1,600 metric tons of material that would otherwise be disposed of can be used in plastic tanks in this way each year. This can save the plant 2,500 metric tons of CO₂ and € 2 million in costs of materials each year.

Use of Recycled Materials in Vehicle Interiors

Using the highest possible proportion of recyclable materials is very important for us. In a flagship project for a special ID. family model, ceiling headliner, fabrics, carpets, seats, door trim and decorative inlays, for example, are being made from sustainable material, which consists of up to 100% recycled materials, for instance PET bottles. An ID.4, for example, contains material equivalent to 140 1.5-liter PET bottles or 380 0.5-liter bottles.

USE OF RENEWABLE RAW MATERIALS

To reduce our resource consumption, we rely on raw materials from renewable sources when manufacturing our vehicles. Wherever possible, our Group brands use renewable raw materials such as the natural fibers flax, cotton, wood and cellulose. Such materials can be used if they comply with all the technical requirements and perform better than conventional materials over the life cycle. In addition, our sustainability standards apply to our suppliers. The following examples illustrate our approach.

> Responsibility for Supply Chains and Business

In collaboration with the Technical University of Liberec, ŠKODA has developed a sustainable, ecological material made from sugar beet pulp, which is used in dyed form in the interior of vehicles to create certain design accents. In addition, ŠKODA is working on another material based on the miscanthus reed, which will also be used in the interior of models in the future. In addition, the Group is investigating the use of other ecologically sourced materials, such as materials based on coconut fibers or rice husks.

RESPONSIBLE USE OF WATER

The supply chain, in particular obtaining and processing raw materials, is responsible for the greater part of our water use. Because we cannot influence these aspects directly – despite our sustainability requirements for suppliers – we concentrate on our production sites. Of all the freshwater that we use, 49.3% (around 15.8 million m³) is used by sites located in risk zones,

i.e. regions experiencing water shortages, such as Mexico. The closed-loop circulation or recirculation of cooling and process water mean the need for freshwater and the quantity of waste water can be reduced considerably. The San José Chiapa (Mexico) Audi site, which can be considered a waste-water-free site due to closed-loop circulation, provides a good example of this. As part of our “goTOzero” concept, our sustainable water management focuses on the following areas of activity:

- Reduction of freshwater consumption and efficiency in water use, particularly in water stress areas
- Minimization of pollution and no worsening of the environmental and chemical status in the receiving waters (waters into which the treated waste water is introduced)
- Increased soil and groundwater protection when using water-polluting substances

We manage water-saving processes at our Group’s locations during production in line with Group-wide specifications. In addition, Volkswagen supports the CDP Water Disclosure Project (WDP) through the transparency of its water management. In 2021, we were given the top grade of A in the WDP ranking for our sustainable water management and are thus back in the leadership index. Given our growing production figures and the integration of new sites, our Group’s absolute freshwater use has increased in recent years. From 2010 to 2021, the quantity of freshwater used per vehicle decreased by 11.6% per vehicle, thanks to a wide range of recycling measures and to the introduction of manufacturing processes requiring little water. The amount of waste water produced is in line with the amount of freshwater that we use. Differences in quantities between fresh and waste water are the result of evaporation in cooling towers and during the manufacturing process.

SUSTAINABLE WASTE MANAGEMENT

Our waste strategy aims to reduce the quantity of waste we produce and to reuse unavoidable waste to create high-quality materials – i.e. to close loops. The focus is on:

- Avoiding waste creation by optimizing production and auxiliary processes and increasing material utilization levels (material efficiency)
- Reducing the quantity of waste produced by processing waste at sites
- Prioritizing the reuse of waste and reducing the quantity of waste that needs to be disposed of

In order to optimize our management of waste, we are increasingly using digital waste management systems in all German and a number of international production locations of the Volkswagen, Volkswagen Commercial Vehicles, Porsche, Audi and MAN brands. They make it easier to control waste management processes and facilitate state control of the disposal of hazardous waste.

In order to monitor waste management and recycling processes, we carry out regular cross-site, cross-brand and cross-OEM waste disposal audits in Germany and the rest of Europe. In addition, the auditors receive further training and hold regular discussions to ensure that they have a common understanding of the quality requirements associated with waste disposal services, to carry out audits of consistently high quality and to allow other OEMs and suppliers to take advantage of the findings.

We reuse waste from manufacturing, logistics, workshops and technical development to produce high-quality materials. Our Procurement Division has established a Group-wide system for recovering waste materials that can generate income – for example, paper, plastics, wood, electronic components or metal. Under the umbrella of the Zero Impact Factory initiative, we are intensifying our efforts to avoid plastic waste with the Zero Plastic Waste project. This includes not only the aforementioned project for recycling plastic waste in diesel tank production but also the future recognition of initiatives for reducing plastic waste in the Volkswagen Group’s Zero Impact Factory Award. Together with the Group brands and various departments from environmental protection, logistics and the production trades, a “roundtable” has also been created. This interdisciplinary working group develops targeted strategies for minimizing the use of plastic packaging. Group-wide regulations that stipulate that any remaining plastic packaging should be recyclable were developed for this. We test innovative options for avoiding plastics here and are guided, wherever possible, by the Group sites’ best practices.

RECYCLING OF VEHICLE PARTS AND TOOLS

Overall, the aim of the high quality focus with a low need for repair is to give our vehicles long lives in the use phase, thus making an important contribution to resource efficiency.

The brands in the Volkswagen Group also take back many used parts from the repair shops, such as engines, transmissions or electronics, because these contain valuable raw materials. These car parts are industrially remanufactured and tested and can then be used in another car again. When they need a repair, our customers can decide whether the repair shop should install an original part – or whether it is preferable to use a Genuine Remanufactured Part. These are comparable to an original part in terms of quality but are much lower in price than new parts. Using these parts saves large amounts of raw materials, energy and CO₂. It is not just vehicle parts that are reconditioned at Volkswagen to conserve resources and save costs; production tools are too. This is what, for instance, the center of excellence for tools at the Salzgitter site is for. An average of 160,000 tools have been processed here each year since 2009 to make them suitable to return to use. This includes rotary-broaching tools, drills or cutters for manufacturing battery anodes and cathodes.

CIRCULAR ECONOMY KPIS

KPI	Unit	2021	2020	Notes and comments
CO ₂ avoided since 2017 through the Aluminum Closed Loop Project	in metric tons of CO ₂	720,000	525,000	
Proportion of freshwater needed at sites in risk zones	in million m ³ /year	15.8	16.7	