Environment

Resource consumption and climate change are major challenges for business and society. With our Climate Strategy 2030, we aim to make a significant reduction in CO_2e emissions within our own production sites as well as across our upstream and downstream value chains. Our EcoDesign approach enables us to take aspects of sustainability into account across the entire life cycle of our products. In use, these products in turn promote the safe, efficient, and sustainable mobility of rail and commercial vehicles.

Environmental Management

With comprehensive environmental management, we seek to continuously reduce the environmental impacts that come from our business activities. Clear processes and local initiatives accelerate the conservation of resources as well as the reduction of emissions and waste at Knorr-Bremse.

The Health, Safety, and Environment (HSE) Policy, revised in 2023, sets out the principles of environmental and energy management in the Knorr-Bremse Group. We want to avoid or minimize any potential impairments for people and the environment that arise from our processes, services and products. In order to realize the corresponding measures, we have put divisional HSE management systems that use standardized processes in place at our locations around the world. HSE management takes account of statutory and customer requirements and internal policies and process instructions. It is an integral component of our company management systems (Rail Excellence [REX] in RVS, Truck Excellence [TEX] in CVS), covering roughly 90% of our employees. Furthermore, our processes are guided by international standards such as ISO 9001, ISO 22163, IATF 16949 (quality management), ISO 14001 (environmental management), ISO 45001 (occupational safety) and ISO 50001 (energy management). There are 77 locations that are certified according to ISO 14001. We follow the European Energy Efficiency Directive in our implementation of energy management. 46 locations globally are currently certified according to ISO 50001 or have had an energy audit analogous to EN 16247. Knorr-Bremse uses internal and external audits to monitor its environmental management, auditing compliance with specified standards in the Group and the implementation of defined improvement measures.

Number of Certified Business Units

	2023	2022	2021
In accordance with the environmental management standard ISO 14001	77	71	70
Percentage of employees covered, in %[1]	89	-	-
In accordance with the energy management standard ISO 50001 or EN 16247	46	37	38
Percentage of employees covered, in %[1]	57	-	-

[1] Prior-year data not available

The central HSE departments of the RVS and CVS divisions are responsible for managing and implementing the environmental management system. They develop strategic guidelines and bring together all cross-location management and coordination tasks. Knorr-Bremse's senior management is involved in strategic and operational environmental management through regular meetings, ad hoc reporting and the ESG Board. HSE managers implement the strategic requirements, goals and programs at the Knorr-Bremse locations with the local managers. Local environmental protection and energy officers, regional coordinators and experts from the departments involved provide support. We aim for largely uniform standards in HSE management across both divisions. There is a regular exchange of expertise both within and between the divisions to this end. This addresses aspects relevant to HSE, best practices, legal requirements and the associated reporting.

Climate Protection

Climate protection is a key focus of Knorr-Bremse's sustainability management. With our Climate Strategy, we wish to contribute to the 2015 UN Paris Agreement targets of limiting global warming to significantly well below 2 degrees Celsius and, through joint efforts, to a maximum of 1.5 degrees Celsius. Knorr-Bremse has committed to a long-term target of net zero emissions (Scopes 1 to 3) by 2050. Milestones on this journey include interim targets for 2030 that were revised during the reporting period and validated by the Science Based Target initiative (SBTi).

Climate targets for production-related emissions (Scope 1 and Scope 2):

We aim to lower our direct Scope 1 emissions and indirect Scope 2 emissions (market-based) by 75% from their levels in the reference year 2018 by 2030. With this target, which was updated in the reporting year, we have once again significantly increased our 2019 climate target of reducing emissions by at least 50.4% over this period.

Production-related Scope 1 and Scope 2 emissions are planned to be reduced by using three main levers:

Climate Week at Knorr-Bremse in France

Knorr-Bremse wishes to continuously raise its employees' awareness of sustainability-related topics. Knorr-Bremse Systèmes Ferroviaires France, Tinqueux, with the support of external organizations, organized a Climate Week with exciting events in June 2023. For example, all employees were asked to attend a "2 Ton Workshop" – as 2 tons less CO_2e per person per year must be achieved in order to reach the Paris Agreement target. During the workshop, the employees learned more about the impacts of their day-to-day actions on the CO_2e balance, whether at work, when eating, or when traveling during their time off. Other seminars taught attendees valuable information on the topics of waste sorting and composting, sustainable mobility, and environmentally friendly home renovation. There were highly practical programs on offer, such as simulator-based eco-driving training and the lending of an electric bike for a month. Tasty meals made from food that was otherwise designated for disposal ensured that attendees were well-nourished. Climate Week was characterized by learning, exchange, and questioning – working together to make everyday life more sustainable.

Increased efficiency of CO_2e and energy	Self-generation of renewable energy	Purchase of renewable energy
Energy efficiency measures and the use of low-carbon fuels in heating systems and in the fleet	Investments in measures to increase the share of our own renewable energy produced at Knorr-Bremse sites	Increase in the share of renewable energy purchased through green electricity tariffs and green power certificates

The internal carbon price implemented in 2023 is an additional tool for steering CO_2e reduction and energy efficiency. It will be included as an additional factor in decision-making in the future when decisions are made on investments of € 500 thousand or more.

-75 %

By 2030, we want to reduce our direct Scope 1 and indirect Scope 2 emissions (market-based) by 75%.

Climate targets for the upstream and downstream value chain (Scope 3):

We extended the Knorr-Bremse climate targets to its value chain at the start of 2023. Our Scope 3 target is to reduce emissions by 25% from their 2021 baseline level by 2030. The announced reduction is aimed at relevant greenhouse gas emissions in key areas of the value chain upstream and downstream of Knorr-Bremse. This includes the indirect emissions from purchased goods and services (category 3.1), upstream transportation and distribution (3.4), and the use of sold products (3.11). It is extremely challenging for Knorr-Bremse to achieve the Scope 3 target because consistent emission reduction depends on many external factors, as well. For example, supplier decarbonization strategies, the availability of technological solutions, or the development of customer preferences with regard to energy-efficient and CO_2e-efficient product solutions are some of the areas that can be mentioned in this context. Consequently, close cooperation with our business partners across the value chain is necessary.

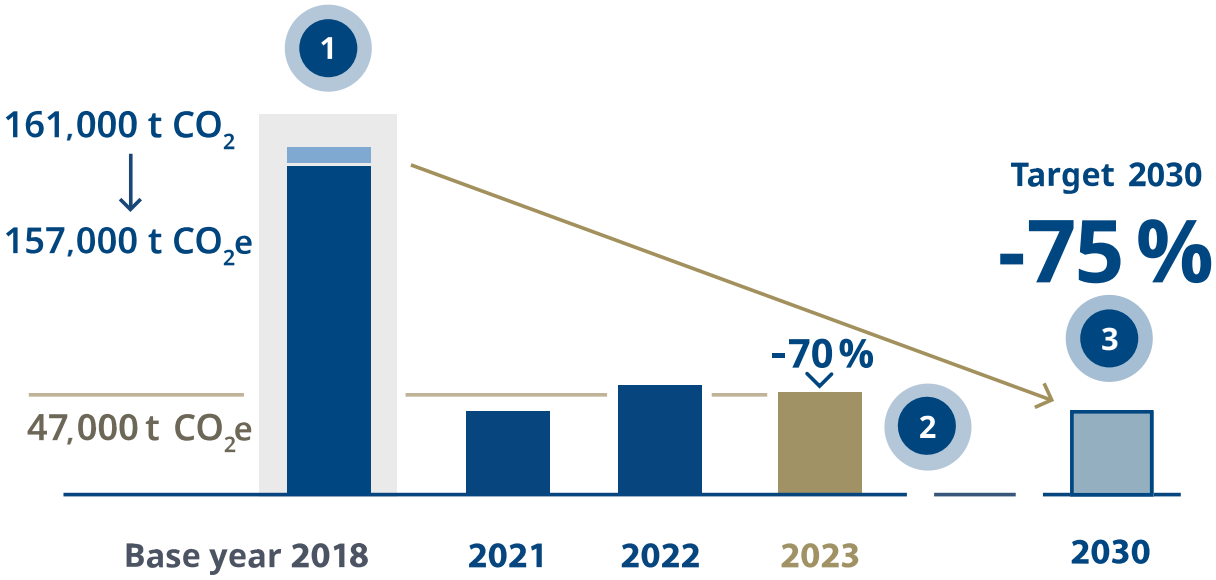
Status of Our Climate Targets

During the 2023 reporting period, we were able to lower our absolute Scope 1 emissions and market-based Scope 2 emissions by approximately 70% from their 2018 baseline level. This positive development reflects the successful implementation of the above levers of increased energy efficiency and CO_2e efficiency, self-generation of renewable energy, and the purchase of renewable energy. Scope 3 emissions rose by approximately 10% from the baseline, caused mainly by an increase in our sales figures in the relevant product categories.

-25 %

By 2030, we want to reduce the key Scope 3 emissions by 25%.

Knorr-Bremse Climate Strategy 2030



1 Recalculation of 2018 baseline level

The values for the 2018 baseline level have been recalculated based on our restatement policy. In addition to the broadening of the reporting unit from CO_2 to CO_2e, this recalculation also reflects our M&A activities, as the foundry of R.H. Sheppard, an investment of the Knorr-Bremse subsidiary Bendix in the US, was sold in 2023. At the same time, recently consolidated subsidiaries, including the RVS division's DSB Component Workshops in Denmark, were included.

2 CO_2e emissions reduced by 70%

In 2023, Knorr-Bremse had already been able to reduce its CO_2e emissions by ~70% compared to 2018. To support the 1.5°C pathway, we will continue to consistently pursue this path and reduce our CO_2e emissions as far and as early as possible wherever economically feasible.

3 2030 climate target

We aim to lower our direct Scope 1 emissions and indirect Scope 2 emissions (market-based) by 75% from their 2018 baseline level by 2030. With this target that we revised in the reporting year, we once again significantly increased our 2019 climate target to reduce emissions by at least 50.4%.

Knorr-Bremse Energy and CO_2e Balance

In 2023, Knorr-Bremse recorded total energy consumption of 482 GWh. This is equivalent to an approximately 8% decrease compared to the previous year. In addition to the consistent implementation of energy efficiency measures, the drop in energy consumption is attributable to the sale of the foundry of R.H. Sheppard, an investment of the Knorr-Bremse subsidiary Bendix in the US. At the same time, recently consolidated subsidiaries, including the RVS division's DSB Component Workshops in Denmark, were included. Around 65% of the total energy demand in 2023 was for electricity and 24% for natural gas. The share of electricity supplied to Knorr-Bremse from renewable sources in 2023 was 95%. The ratio of self-generated electricity to purchased electricity is 1.8%.

Energy Consumption[1]

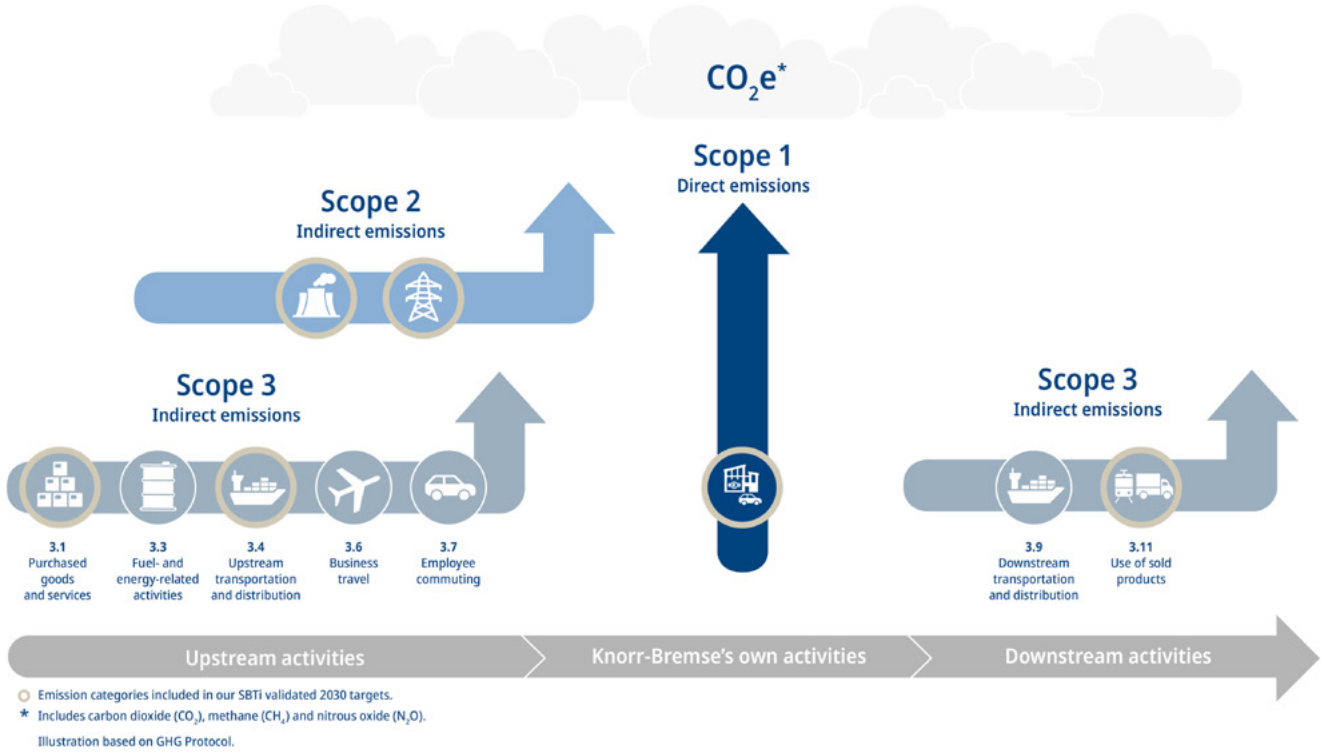
		2023	2022[2]	2021[2]	2018[2]
Primary energy consumption	in GWh	160	**180**	**131**	155
Natural gas	in GWh	118	138	99	120
Fuels	in GWh	37	39	31	34
Self-generated renewable energy	in GWh	6	2	1	0
Secondary energy consumption	in GWh	322	**344**	**301**	326
Purchased electricity	in GWh	311	336	287	314
Of which renewable energy	in %	95	94	98	13
District heating	in GWh	11	8	14	12
Total energy consumption	in GWh	482	**524**	**431**	481
Energy efficiency	in MWh/ € millions of revenue	60.8	**73.3**	**64.3**	72.7

[1] The figure for 2023 relates to all sites under operating control, excluding locations with fewer than 50 employees other than production locations or service workshops. This covers around 94% of Knorr-Bremse's employees.

[2] The data from the baseline year 2018 has been recalculated in line with our restatement policy. The data from 2022 and 2021 was not retroactively adjusted.

Knorr-Bremse's CO_2e reporting is aligned with the Greenhouse Gas Protocol (GHG Protocol) and takes into account the emissions from key areas in the value chain. A detailed description of the calculation method can be found here:→ CO_2e Calculation Method.

Overview of relevant Emission Categories at Knorr-Bremse



In line with the lower energy consumption, our absolute Scope 1 and market-based Scope 2 emissions in 2023 fell to approximately 47,000 tons of CO_2e. The emission intensity (Scope 1 and 2) amounted to 5.9 tons of CO_2e emissions per million euros of revenue during the reporting period. The use of natural gas by Knorr-Bremse was the primary source of approximately 36,000 tons of Scope 1 emissions that were identified in 2023. The indirect, location-based Scope 2 emissions tallied up to roughly 117,000 tons of CO_2e and were mainly from the consumption of purchased electricity at the Group locations.

Direct and Indirect CO_2e Emissions[1,2]

		2023	2022	2021	2018[3]
Scope 1 direct CO_2e emissions	in thousand metric tons of CO_2e	36	38	28	41
Scope 2 indirect market-based CO_2e emissions	in thousand metric tons of CO_2e	11	12	7	116
Scope 2 indirect location-based CO_2e emissions	in thousand metric tons of CO_2e	117	122	152	141
Total market-based CO_2e emissions	in thousand metric tons of CO_2e	47	**50**	**35**	157
Total location-based CO_2e emissions	in thousand metric tons of CO_2e	154	**160**	**180**	182
CO_2e intensity	in metric tons of CO_2e/ € million of revenue	5.9	**7.0**	**5.2**	23.7

[1] The recording of CO_2e emissions is aligned with the recognized requirements of the Corporate Accounting and Reporting Standard (Scopes 1 and 2) of the Greenhouse Gas Protocol. The figures from 2022 and 2021 were not adjusted retroactively for M&A activities and divestments.

[2] The CO_2e data recorded in 2023 includes emissions of carbon dioxide (CO_2) as well as other climate gases defined by the GHG Protocol, such as nitrous oxide (N_2O) and methane (CH_4) as well as emissions resulting from refrigerant leakage. The comparison data from 2022 and 2021 only includes CO_2 emissions unless indicated otherwise.

[3] The values for the 2018 baseline level have been recalculated based on our restatement policy. In addition to the broadening of the reporting unit from CO_2 to CO_2e, this recalculation also reflects our M&A activities.

The Scope 3 greenhouse gas emissions in the reported categories rose by approximately 10% compared to the baseline level to 42,145 thousand tons of CO_2e. This was caused mainly by an increase in the sales figures in the relevant product categories. Furthermore, an improved calculation method was applied for Scope 3.6 and especially for Scope 3.11. The comparability of the emissions with previous years is therefore limited. During the reporting period, our focus was primarily on improving data quality and analyzing the largest drivers of emissions in order to derive measures based on them. On the subject of procurement-related emissions, we have begun analyzing the raw materials and suppliers with the greatest potential for reductions. A pilot project was launched in this context in 2023 to analyze the emission data from suppliers (→ Sustainability in the Supply Chain). To reduce transportation-related emissions, we collected and analyzed data on our operational transportation management and network. The resulting optimizations pertained to transportation between Knorr-Bremse locations as well as delivery to customers. We design our products, such as systems for electrified passenger and cargo transportation, to be as environmentally friendly as possible by applying technological innovation. They are intended to be low-emitting and resource-conserving in usage across the entire product life cycle.

Financial Support for Climate Protection Projects in Kenya and India

As a further contribution to climate protection, we are maintaining our commitment and supporting two atmosfair gGmbH climate protection projects certified in accordance with the Gold Standard: a project for clean drinking water in Kenya and a project for efficient wood gasifier ovens in India. These projects were selected jointly with Knorr-Bremse Global Care e.V.

In 2023, global emissions of approximately 40,000 tons of CO_2e were avoided with the help of a project in India for efficient wood gasifier ovens. In collaboration with the local project partner, Calcutta-based Sapient, low-income households in the rural region of western Bengal are provided with efficient wood gasifier ovens, which can reduce firewood consumption by 50% to 60%. The ovens enable people to cook without smoke, and the wood gasification process generates charcoal that they can then sell. At the same time, the lower wood consumption helps conserve the mangrove forests in western Bengal. The goal is to distribute a total of 30,000 new ovens subsidized by Knorr-Bremse by 2030.

The project for clean drinking water of the local partners Boreal Light GmbH and Waterkiosk Ltd. supports access to clean drinking water for rural households in Kenya. These efforts help to avoid transmission of water-borne diseases. There are now 38 solar-powered water treatment facilities in operation, with approximately 44 million liters of water being desalinated and purified each year. The result is clean drinking water for approximately 50,000 people, and the units also produce process water. The first monitoring period was concluded in late 2023. In addition to the monitoring of the CO_2e emissions prevented by the project, a study is being conducted in collaboration with Knorr-Bremse Global Care e.V. to identify the positive health effects enjoyed by the local population.

CO_2e Emissions in the Value Chain (Scope 3)[1]

		2023	2022[6]	2021[6]
3.1 Purchased goods and services	in thousand metric tons of CO_2e	1,986	1,802	2,025
3.3 Fuel- and energy-related activities[2]	in thousand metric tons of CO_2e	25	27	29
3.4 Upstream transportation and distribution[3]	in thousand metric tons of CO_2e	198	184	200
3.6 Business travel[4]	in thousand metric tons of CO_2e	13	6	4
3.7 Employee commuting	in thousand metric tons of CO_2e	23	25	26
3.9 Downstream transportation and distribution[3]	in thousand metric tons of CO_2e	46	47	50
3.11 Use of sold products[5]	in thousand metric tons of CO_2e	39,853	26,301	36,092
Scope 3 emissions, total[7]	in thousand metric tons of CO_2e	**42,145**	**28,393**	**38,426**

[1] A detailed description of the calculation methodology can be found (→ **CO_2e calculation method)**.

[2] For fuel- and energy-related emissions, the emission savings from the purchase of green electricity will be taken into account from reporting year 2023 (market-based approach). The years 2022 and 2021 were retroactively adjusted.

[3] For Commercial Vehicle Systems, a large part of the footprint is based on primary emission data supplied by suppliers. A further part was calculated using a distance-based approach, while the remaining part was calculated using a spend-based approach. For Rail Vehicle Systems, the footprint was calculated based on a purely distance-based approach.

[4] The calculation of emissions from flights is based on the different calculation methods depending on the travel agency. In 2023, Thrust Carbon was used for the first time for some of the countries, thereby including other emission-relevant factors in addition to flight distance and travel class. As a result, it is not possible to compare this emission data with the previous year.

[5] Knorr-Bremse incorporated long-term field test data from the CVS division in its calculation of Scope 3.11 emissions for the first time in 2023, and thus further increased the data quality. As a result, it is not possible to compare this 2023 emission data with the data from 2022, but it is possible to compare it with the base year 2021.

[6] The values for Scope 3.1, Scope 3.4 and Scope 3.11 for the 2021 baseline level have been recalculated based on our restatement policy. The figures from 2022 were not retroactively adjusted.

[7] Deviations are due to rounding differences.

Climate Risks and Opportunities

The consequences of climate change, as well as global decarbonization in an attempt to limit climate change, come with potential risks – as well as opportunities – for Knorr-Bremse. They include, for example, extreme weather events, and costs associated with regulatory requirements or, on the other hand, rising demand for our efficient product solutions. We therefore analyze our climate-related business risks and opportunities as part of Group-wide → risk management.

Furthermore, we align ourselves with the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) for reporting on climate-related business risks and opportunities. Using a qualitative scenario analysis, we identified potential risks in our internal production, the supply chain, and in the markets. In accordance with the Do No Significant Harm requirements of the EU Taxonomy Regulation, a detailed climate risk and vulnerability analysis was additionally carried out in 2023.

→ TCFD-Table

Climate Protection Measures at Group Locations

There are numerous colleagues who are contributing to the implementation of the Climate Strategy 2030. They include divisional representatives from the EcoDesign, Purchasing, Engineering, and HSE departments as well as Logistics and Supply Chain Management, accompanied by representatives from the Knorr-Bremse North America/South America and Asia-Pacific regions, the Sustainability department, and Energy Purchasing. Local environmental and energy management has the task of evaluating and improving processes in the Group on an ongoing basis with respect to energy requirements. For example, consumption data can be monitored at locations, potential savings can be found, and the efficiency of any measures implemented can be audited. A new cross divisional reporting tool that was implemented in 2023 is harmonizing data collection and management. The transparent data basis is intended to simplify the management and reporting of KPIs just as much as it does information exchange. Find out here in concrete terms how we realized our climate targets in 2023 by using our three levers:

Saving Energy: Employee Activities at Bendix

Knorr-Bremse actively promotes its employees' energy conservation ideas, with Bendix, for example, putting on an Energy Treasure Hunt at its Bowling Green production location.

This three-day event served as a playful way for Bendix to initiate its implementation of an energy conservation project. Seventeen employees working together with the US Department of Energy became successful treasure hunters. They uncovered potential energy and gas savings at the location worth more than $250,000 (–21%), with a volume of 1.6 tons of CO_2e (location-based). The air leakage, for example, was significant, and its containment – in combination with other repairs – makes an entire air compressor surplus to requirements.

→ More about local sustainability projects at Bendix

Increasing CO_2e and energy efficiency

To increase CO_2e efficiency and energy efficiency, we identify potential and, as a result, projects for saving energy using internal and external analyses. The energy conservation projects completed during the reporting period included an expanded modernization of the HVAC system at the Acuña, Mexico, location and the conversion of gas-operated heating systems to heat pumps in Budapest, Hungary. Further examples include the exchange of a compressor in Italy and the utilization of waste heat from air compressors in China.
As in previous years, we replaced conventional lighting systems with LEDs at multiple locations and implemented additional projects for reducing fossil fuel consumption, e.g., electrifying kitchen appliances in Mexico. With the measures realized at the locations since 2019, we expect energy savings of around 16,700 MWh per year. In 2023, new energy-saving projects with potential savings of approximately 11,100 MWh per year were also approved.

Self-generation of renewable energy

Photovoltaic systems supply self-generated electricity from renewable sources at multiple locations globally: Suzhou, China; Palwal, India; Darra and Granville, Australia; Getafe, Spain; Florence and Milan, Italy; Melksham, UK; Huntington, US; Acuña, Mexico; and Munich and Schwieberdingen, Germany. In total, Knorr-Bremse generated approximately 5,600 MWh of renewable energy in 2023, around 3,200 MWh more than in the previous year. Further investments in PV systems in Kecskemet, Hungary; Kempton Park, South Africa; Mödling, Austria; and Rzeszow, Poland, and expansion of the systems in Acuña, Mexico; Munich, Germany; and Suzhou, China, were approved in 2023. These new systems are likely to increase the company's renewable energy self-generation capacity by around 6,100 MWh per year.

Purchase of renewable energy

Of the power supplied to Knorr-Bremse in 2023, approximately 95% was from renewable energy sources and purchased via green power contracts or certificates. Renewable electricity is purchased via a green power contract for our locations in Sweden, France, and Brazil, and we obtain green energy certificates for additional global Knorr-Bremse sites. In Europe, these are European proofs of origin, with the exception of specific local proofs of origin in Poland and the United Kingdom. Renewable Energy Certificates (RECs) are used in the US and Canada, and International Renewable Energy Certificates (I-RECs) are used in China, India, Thailand, Mexico, South Africa, and Turkey. For the purchase of green energy certificates, Knorr-Bremse has defined quality criteria that must be met as far as possible. They include details about energy sources, the year and location of generation, and the age of the systems, among other information.

Photovoltaic Systems Produce Electricity for Production Sites

Huntington, USA

Award-Winning Solar Project

The 1,168-megawatt solar project at Bendix in Huntington, USA, received the prestigious "Governor's Award for Environmental Excellence" from the state of Indiana in 2022. Connected to the grid in 2021, the PV system noticeably reduces Bendix's environmental footprint while saving costs.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
1,500 MWh	**approx. 10%**	**530** tons

Acuña, Mexico

PV Systems for Two Plants

At the Bendix plants in Acuña, Mexico, PV systems on two mills have been generating and supplying electricity since December 2022. The future total output is expected to be around 2,000 MWh per year. 1,296 solar panels were installed on each plant roof for this purpose.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
2,089 MWh	**approx. 9%**	**835** tons

Florence, Italy

"Florence Sunlight" Project

The new PV system at Knorr-Bremse Rail Systems Italia, Florence, generates approximately 380 MWh of energy annually with 900 photovoltaic modules and a peak output of 320 kWp. This meets up to 80% of the site's electricity requirements and can reduce CO_2e emissions by well over 100 tons per year.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
380 MWh	**up to 80%**	**100** tons

Getafe, Spain

PV System for Energy Self-Sufficiency

At Knorr-Bremse Spain in Getafe, a PV system installed on the factory roof went into operation in 2022. Generating 569 MWh of electricity per year, it will meet around 30% of the location's own electricity consumption. In addition to significant cost reductions, CO_2e emissions are expected to fall by 87 tons annually.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
569 MWh	**approx. 30%**	**87** tons

Various locations, Australia

Four New PV Plants

Since 2022, new PV systems have been supplying Knorr-Bremse with its own green electricity at four locations in Australia. Larger systems were installed in Granville, with 728 solar modules (300 kWp), and in Darra, with 242 modules (100 kWp). The plants are expected to reduce CO_2e emissions by nearly 360 tons per year.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
530 MWh	**29%**	**360** tons

Faridabad, India

Existing 75 kW Rooftop PV Power Plant

A 75 kW grid-connected rooftop PV power plant was installed in 2016.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
91 MWh	**approx. 1%**	**63** tons

Munich, Germany

Further Expansion of Solar Power Generation at Headquarters

The headquarters of Knorr-Bremse in Munich already had PV systems installed. PV capacity was added on the rooftops of two buildings in 2023. With this addition, the total estimated PV generation is expected to meet approximately 5.6% of the total electricity needs of the complex.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
628 MWh	**approx. 6%**	**220** tons

Schwieberdingen, Germany

Rooftop Photovoltaic System

Knorr-Bremse in Schwieberdingen has installed a solar system across the rooftop of the building, with 267 solar panels fitted. The panels deliver a nominal output of 98 kWp. The energy is used for the company's own consumption.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
91 MWh	**approx. 5%**	**71** tons

Melksham, UK

New Solar Panel Plant Installed

A solar PV system was installed in February 2023. With a total of 1,430 individual solar panels combined, it has a 565 kWp maximum capacity, which would supply around 17–25% of the average total facility demand throughout the year. With less than 8% of the weekly generation being released back to the grid, the remaining amount goes toward meeting all of the baseline demand.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
< 565 MWh	**> 17–25%**	**> 99** tons

Reims, France

New Photovoltaic Car Park Canopy

A new solar panel canopy with an installed capacity of approximately 85 kWp has been set up above a parking lot in France. The project meets more than 15% of the location's annual consumption.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
85 MWh	**approx. 15%**	**5** tons

Milan, Italy

New Solar Panel Plant Installed

A new rooftop solar power plant has been completed at the Microelettrica Scientifica location in Milan. The planned generation is largely aligned with the energy demand of the plant, which will use most of the energy generated.

Electricity production per year	Coverage of internal demand	CO_2e emissions reduction per year
741 MWh	**approx. 50%**	**229** tons

Suzhou, China

New Photovoltaic Power Station

A new photovoltaic power station was constructed at the Suzhou location in 2023, expanding the already existing photovoltaic capacity from more than 200 MWh to nearly 1,200 MWh of renewable electricity output every year. With this expansion project, renewable electricity utilization is expected to make up 10% of total electricity consumption by the Suzhou plant.

Electricity production per year[1]	Coverage of internal demand	CO_2e emissions reduction per year[2]
954 MWh	**approx. 10%**	**585** tons

[1] in the first year and an average of 881 MWh throughout its life cycle

[2] in the first year and an average of 540 tons throughout its life cycle

Resource Conservation

Knorr-Bremse wants to reduce the use of raw materials and supplies and, as far as possible, recycle them. This concept of reducing use and the circular economy applies to all waste as well as water. In principle, our waste management practices are designed to avoid waste – be it raw materials generated during production, packaging or other waste on-site. At the same time, we strive toward the sustainable use of water and, in doing so, account for the different requirements and needs of our locations around the world.

Packaging and Resource Conservation

Using packaging smartly has the potential to lower resource consumption and costs significantly. This can be achieved by reusing materials or with a new packaging solution, like at Knorr-Bremse Systems for Rail Vehicles in Suzhou, China.

Environmentally Friendly Protective Packaging: Fabric Replacing Plastic

When a cable harness box is shipped, the external plugs need to be protected against scratches and bumps. Previously, Knorr-Bremse in Suzhou had used disposable air cushions to do this. They provide good protection, however they need to be disposed of immediately after usage. So, a few committed employees set out to look for an alternative that produced less waste. A solution was found in the form of protective fabric bags which are easy to transport and reusable.

Recyclable Packaging: Heavy-Duty Cardboard Replaces Wooden Crates

Previously, Knorr-Bremse in Suzhou delivered aluminum brake disks to its customers in wooden packaging. These are very secure containers, though they are also resource-intensive and are disassembled and disposed of after delivery. The new packaging box made of recyclable, heavy-duty cardboard was designed in consultation with the customers. Extensive testing was carried out afterwards (including stacking and crash tests). The internal findings and the customer feedback were analyzed and the packing instructions updated. The new packaging uses roughly 30 kilograms less wood per crate, for a total annual saving of thousands of euros in material costs.

Global Waste Management

For its waste management, Knorr-Bremse is guided by the principle of a circular economy, with the primary objective of avoiding waste. If this is not possible or economically viable in a particular case, we endeavor to ensure environmentally friendly reuse. Overall, Knorr-Bremse focuses on three points in its global waste management:

- Avoiding waste through the targeted and optimized use of resources
- Substituting materials with environmentally friendly input materials, avoiding the use of single-use plastics, for example
- Promoting the circular economy for the environmentally friendly recycling or reuse of materials

Waste at Knorr-Bremse consists largely of scrap metal, paper and residual waste. As a company in the production sector, we produce steel and iron materials, light metals, polymers, consumables and packaging materials. In addition, we generate electroplating sludge during the surface treatment of metallic materials. The total waste volume at the Knorr-Bremse Group during the reporting period was 69,000 tons, of which 13% was hazardous waste; 83% of non-hazardous and 66% of hazardous waste was fed into recycling processes.

The Knorr-Bremse production system (KPS) supports the reduction of waste volumes in production. Using value stream analyses, we identify and eliminate various types of waste such as overproduction and avoidable reject products. Knorr-Bremse itself tries to avoid or reduce packaging as far as possible and to utilize reusable materials and containers. Our quality guidelines direct our suppliers to take similar actions.

Global Water Management

We strive to use water as efficiently as possible and, if possible, to use it more than once as part of a closed-loop system. Knorr-Bremse uses water in particular for surface treatment and cleaning of its products, for test applications and as drinking and plumbing water. The usage of water varies strongly by location. We obtain our water from public utilities. To reduce our consumption of drinking water, we use rainwater for cleaning, for sanitary facilities and for watering green areas at some locations. We get rid of wastewater via public wastewater systems.

Water consumption[1]

in thousands of cubic meters

[1] The figure for 2023 covers more than 80% of Knorr-Bremse´s employees.

[2] The year-over-year reduction in water consumption is the result of the introduction of new production processes and the sale of water-intensive business units. The water usage of some locations in the Commercial Vehicle Systems division for 2023 was extrapolated from the previous year's consumption based on revenues and other environmental metrics.

Reduced Water Consumption: Overhauling Process in Brazil

Knorr-Bremse opened an overhauling plant at an operator for agricultural products in Rio Claro, Brazil, in 2018; the operator had previously done this work by himself. Knorr-Bremse reconditions locomotive and freight car braking systems at the plant in accordance with "green value" principles and tests these systems. Its aim here is to reduce resource usage further and to recycle materials. That applies to the washing process as well, a process which roughly 500 components go through each month as part of the repair work. Over the five years in which the facility has been operating, the system has already saved around 1.7 million liters of water and reduced the use of chemical products by more than 115,000 liters.

Environmental Product Design

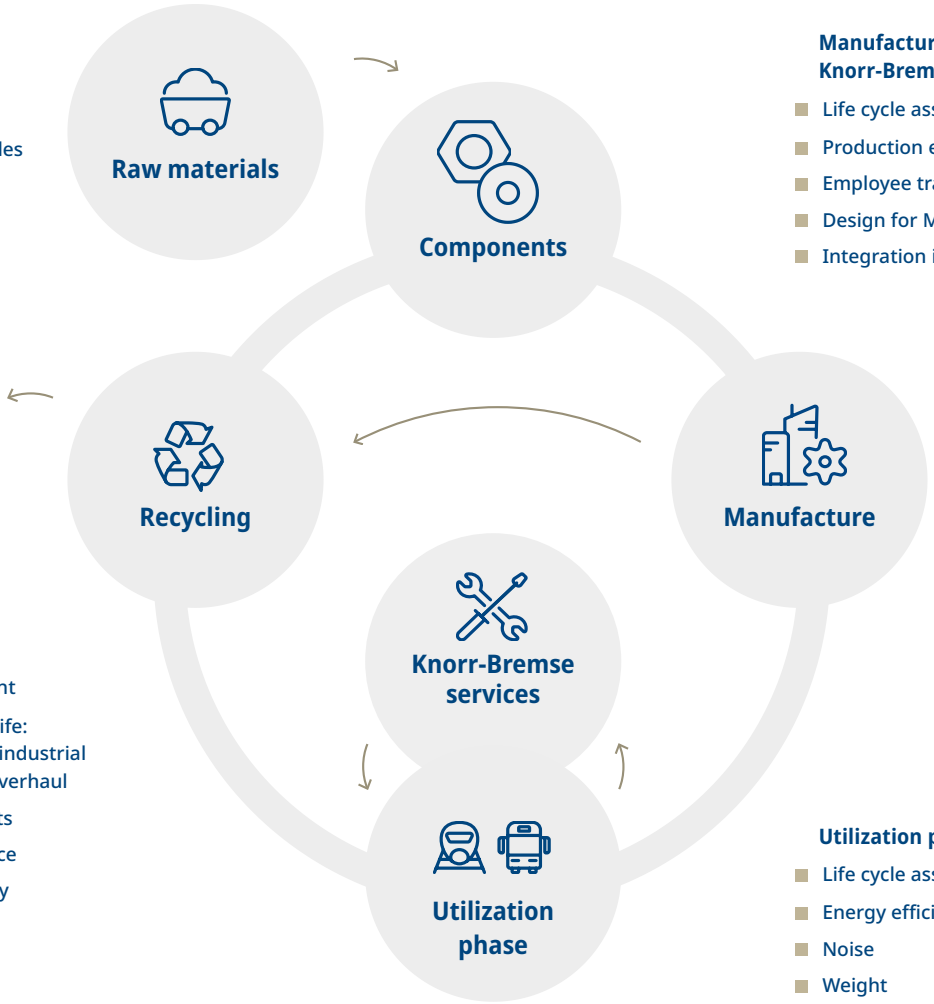
Knorr-Bremse can make a contribution to climate and environmental protection with systematically environmentally oriented product development while achieving a medium- and long-term competitive edge. Knorr-Bremse EcoDesign – environmental product design – enables us to develop products, processes, and services with an improved environmental impact across the complete product life cycle. We thus want to ensure a future-proof product portfolio and, at the same time, pursue our company vision and HSE policy. With the EcoDesign approach, in addition to various internal requirements, the requirements of regulatory stipulations, standards, and customer expectations also influence product development. The focus here is on sustainability aspects such as a long service life, conservation of resources, and avoiding emissions.

EcoDesign Entrenched within the Organization

EcoDesign is organizationally incorporated into both divisions in such a way that it supports strategic research and development (R&D) planning and creates synergies and standardized processes between the Group divisions. The EcoDesign experts of the RVS and CVS divisions have one central function here. They are integrated into the development processes and help, with the assessment of product development, for example. They are supported in this by divisional analysis teams, which analyze Knorr-Bremse products and components in respect of compliance with internal, legal, and customer requirements on content. A specially developed EcoApp supports the analysis of the products in the RVS division. The EcoDesign experts work together closely and across divisions on a project basis. Thanks to the regular exchange, synergies can be leveraged in the transfer of know-how and common standards compiled for product development. During the year under review, the focus was, in particular, on recording the Scope 3 emissions in product use and identifying reduction potential (→ Climate Protection).

Intensive training of engineering and R&D employees over the past few years has given them a shared understanding of EcoDesign standards for evaluating product development. We continue to offer this training as needed. For example, training for engineers from the Bendix subsidiary (CVS division) was held in 2023. In RVS, EcoDesign analysts were trained on upcoming statutory environmental regulations.

EcoDesign in the Value Chain



Raw materials and Components

- Compliance with rules and regulations
- Choice of materials
- Avoiding prohibited substances

Manufacture by Knorr-Bremse

- Life cycle assessment
- Production efficiency
- Employee training
- Design for Manufacturing
- Integration in R&D

Reuse, recycling and disposal

- Life cycle assessment
- Extending product life: Modernization and industrial remanufacturing/Overhaul
- Reusing components
- Product maintenance
- Product dissasembly

Utilization phase

- Life cycle assessment
- Energy efficiency
- Noise
- Weight

EcoDesign in Development Processes

Knorr-Bremse wants to proactively integrate EcoDesign aspects into product development and is working on systematically anchoring sustainability criteria in the processes – from strategic planning through innovation to product development.

Strategic Planning

In strategic planning, the business units determine their goals on a product and system level for the next five years. In addition to many other aspects, product sustainability is an integral part of this process. As such, EcoDesign criteria such as selection of materials, energy efficiency, reduction of emissions and life cycle are taken into consideration.

Innovation

In our innovation process, we assess projects' and product ideas' potential for development and implementation, including on the basis of their alignment with strategically relevant megatrends. In the RVS division's innovation projects, EcoDesign is one of five different assessment criteria in the planning process. In the reporting period, 110 projects were classified in terms of EcoDesign criteria. All innovation projects are assessed using a criteria catalog that includes the topic of sustainability. The resulting priority list for the projects is discussed and adjusted at management level. A higher priority generally means a higher probability of project implementation. The size of a project budget is based on the responsible department's coordinated project and budget planning.

Product Development

When developing new products and solutions, we want to incorporate and minimize their environmental impact from the start. This is why we assess them along the product life cycle in accordance with EcoDesign criteria and derive improvements from this. Both divisions have introduced a binding process that takes account of the following EcoDesign criteria:

Material extraction and production phase:

- Hazardous substances
- Weight (CVS division)
- Choice of materials (including proportion of secondary materials)
- Origin of materials (conflict minerals)

Usage phase:

- Weight (RVS division)
- Energy efficiency
- Longevity
- Direct emissions

End of product life:

- Recyclability

Product Development: Analyses and Tools for Minimized Environmental Impacts

In the RVS division, the EcoDesign assessment form is provided to the development teams for the mandatory assessment of innovation projects and complex customer projects. It defines requirements for product design and makes assessment tools available, such as supporting standards and methods for evaluating environmental impacts. For example, the recyclability analysis of the materials used helps us to identify and reduce their potential environmental impact. In 2023, a total of 28 projects in the RVS division were reviewed on the basis of a recyclability analysis in accordance with ISO 22628 and/or ISO 21106. Here, the result of the rail vehicle business area's products is more than 90% recyclability for Knorr-Bremse products.

Usage of the EcoDesign assessment (CVS)

The EcoDesign assessment form was used as part of a project for the development of a truck pedal unit to create a unit design that had a small environmental footprint. In particular, the parameters of component weight, material choice, and share of recyclates were assessed. This corresponded fully with customer expectations of lower CO_2e emissions.

The CVS division has defined concrete EcoDesign requirements and targets in the product development and commercialization (PDC) process for new products and products with material changes. These requirements and targets – for example, a minimum reduction in weight – need to be implemented in the phases of project planning through to the product and process development. Specific guidelines and concrete tools and methods assist with this process. These include the IMDS system for identifying hazardous materials and materials requiring declaration, comparative analyses of material-specific environmental impacts, and the EcoDesign assessment form.

Moreover, Knorr-Bremse also used life cycle analyses (LCAs) in 2023 to calculate product-based environmental impacts comprehensively. While the RVS division conducted LCAs on brake resistor and the i3HU hydraulic unit products, CVS carried them out on pneumatic disk brakes. The analyses deliver valuable insights on the use of materials and energy in production and on impacts in the product use phase through to disposal. The LCAs were conducted in accordance with standards such as ISO 14040 and the UNIFE Product Category Rules.

Life cycle analyses: environmental impacts of selected Knorr-Bremse products

Dessicant material used for drying air in pneumatic systems (such as truck braking systems). A project was established under the Commercial Vehicle Division in 2023 to determine the feasibility and the potential benefits of the remanufacturing of this substance. As part of this project, an LCA was carried out that showed massive environmental benefits, including significant savings in associated CO_2e emissions and the avoidance of landfilling tons of used materials

- 1,000 tons CO_2e

Based on the LCA, close to **1.000 tons CO_2e** emissions were avoided in 2023 by the remanufacturing of desiccants.

HydroControl Smart is an extremely compact, lightweight and robust intelligent hydraulic unit concept in development that combines versions with or without integrated brake electronics, using one unified design. Designed for the demanding operating conditions of modern public transportation systems, it is suited to a wide range of vehicle types. Its high power density, modular extendable system layout, connectivity and data management features make it a perfect choice for hydraulic railway brake systems.

- 15% CO_2e

Based on the LCA carried out in 2023; After its re-design, the total **CO_2e** footprint during the whole life cycle of the product was reduced by close to **15%** compared to an equally performing combination of HydroControl Classic hydraulic unit and brake electronics.

Saving Resources through Industrial Remanufacturing

Our RailServices and TruckServices business is another driver of sustainable product design. This includes, among other things, overhauling in the RVS division and remanufacturing in the CVS division, which are key lines of business. With these services, Knorr-Bremse industrially remanufactures products so that they can be reused in a transportation context with identical functionality. The extended product life cycle results in reduced material usage and energy consumption simultaneously, which influences both our and our customers' life cycle assessment positively.

Because we design our products to be ready for remanufacturing and overhauling during the development and design stages, it is possible to use them for longer. Knorr-Bremse TruckServices currently has products representing roughly 1,000 item numbers in its EconX portfolio for the Europe/Africa region. The brand stands for a circular economy and includes remanufactured components, e.g., for braking systems. The completely reconditioned products are installed in trucks again and individual parts and commodities are recycled directly. Thanks to industrial refurbishment, 3,648 tons of CO_2, 1,220 tons of materials and 18,987 MWh of energy were saved in the reporting period.

If rail vehicle customers have inquiries about overhauls and repairs, they can turn to one of the 50 Knorr-Bremse service centers globally, with this network recently having been expanded to include locations in Denmark, the UK and Italy, among other places. Numerous delivered components are regularly overhauled at the service branches, and, following a successful check, installed back in the respective fleet or vehicle. The goal is for the components to maintain functionality until the end of the corresponding train's life. One example in this regard is compressors, which are overhauled after defined intervals or set hours of operation. Moreover, exchanging a component or implementing additional functionality may also form part of a complete upgrade or modernization project. These full maintenance packages have the potential to extend an entire train's useful life.

Knorr-Bremse refurbished around 67,000 products of various kinds at the service center in Berlin in 2023. In China, braking equipment for more than 5,300 high-speed train cars, 2,000 locomotives, and nearly 4,200 product units for metro trains were refurbished in 2023. On top of that, approximately 2,500 entrance systems and 1,280 HVAC systems were delivered for high-speed and metro trains.

Remanufacturing: Good for Development

Knorr-Bremse, applying its EcoDesign approach, considers the separability of its individual components from as early as the product development stage. In doing so, Knorr-Bremse acts ahead of forthcoming legislation, the European Ecodesign Directive, and the right to repair. Remanufacturing also drives product innovation in the Commercial Vehicle Systems division, as the division's developers get to find out a great deal about product behaviors during long-term usage in the field. Using a remanufacturing road map and working on a project basis, TruckServices tracks the products that will likely enter the independent aftermarket in the foreseeable future. First, the spare parts for a product need to be available, with remanufacturing products seeing greater demand after about six years. Behind these development projects are business cases that have been coordinated with OE customers. The technology – whether it is a component for a combustion engine or an electric motor – is of secondary importance.

Revenue[1] from Refurbished Products Relative to Group Revenue

[1] Revenue including labor and spare parts needs

Eco-Friendly Logistics

Knorr-Bremse strives for eco-friendly logistics across the entire value chain. We optimize the operational transportation management on an ongoing basis, including with the help of external service providers. These service providers take over the planning, consolidation, and operational execution of deliveries from external suppliers to Knorr-Bremse as well as the transportation between the Knorr-Bremse locations and the deliveries to our customers.

We seek to minimize the costs as well as environmental impacts of product transportation. We constantly optimize the coordinated use of rail, road, and shipping routes. We achieve this through the use of standardized processes and methods, which, at the same time, increase our service quality across all distribution channels with regard to delivery reliability, delivery quality, and delivery deadlines. In 2023, too, we primarily carried out intercontinental product transportation by ship. Our target utilization rate of at least 85% for sea freight containers (CVS) supports efficient goods transportation. Rail transportation from China to Europe was used in certain cases as a safeguard for production. We avoid air freight transport whenever possible.

We calculate the CO_2e footprint of the global transportation network (→ Climate Protection) and are working on improving it. Going forward, CO_2e emissions caused by transportation will increasingly play a role in decision-making for optimizations in logistics. Commercial Vehicle Systems, when carrying out new sourcing procedures in the past, has already calculated and assessed the CO_2e emissions generated through transportation. To make a systematic, quantitative assessment of CO_2e reduction measures and track them, the CVS division began rolling out a transportation management system (TMS) in 2023. It is being introduced in Europe first and will then be implemented in the Asia-Pacific and South America regions. The TMS already established in North America will be expanded to include additional CO_2e KPIs. Along with the transparency it creates, the additional monetary evaluation will also incentivize the reduction of CO_2e emissions.

Further emission-reducing measures in the RVS division are supported by the "NextGen European Distribution Network" project, which has created a digital twin, among other things. Using the bottom-up calculation method, this has enabled reproducible CO_2e reporting and analysis in real time for the transport network since 2022. These findings are incorporated into decision-making processes in the transportation sector and form the basis for initiating sub-projects for CO_2e reduction. In addition, the European distribution structure close to our locations (RVS) in Spain, Hungary and Germany, which was redesigned as part of the "NextGen European Distribution Network" project, was further developed in 2023 so that transportation flows can be made more efficient and with lower emissions. In 2024, the concept is planned to be expanded for greater consolidation of the deliveries to North America and China.

Knorr-Bremse continuously reviews and analyzes the transportation flows in conjunction with its logistics contractors. This allows for shipments to be consolidated and CO_2e emissions lowered, for example. This results in local projects with reduced emissions, such as in Aldersbach, Germany, Liberec, Czech Republic, or Huntington, United States.

The Commercial Vehicle Systems division is pursuing a reduction of the carrier portfolio in the Europe/Africa region with a reinforced focus on strategic partnerships. The smaller number of interfaces with forwarding agents is a further measure to enable more efficient CO_2e management. We will work on comparable steps in the Asia-Pacific and South America regions as well.

The CVS division has implemented a central tracking process for the Europe/Africa region for optimized logistics in connection with global special freight shipping. The special freight shipments that are carried out or pending are analyzed in regional sales inventory planning (SIOP). Countermeasures such as inventory increases can be defined using the results.

CO_2e Reduction in Logistics: Transformation Project Being Expanded

Increased efficiency, lower costs, and less carbon emissions in the logistics across the supply chain – these are all things represented by the NextGen European Distribution Network transformation project in the RVS division. Knorr-Bremse's European logistics and supply chain network optimizes economic and environmental factors according to eleven criteria, including targets for logistical quality. As a result, the number of ton-kilometers driven was able to be reduced by 20% and thus logistics costs and CO_2e emissions by a significant amount. This occurred simultaneously with increased logistical speed and flexibility for customers.