

# Environment

We are dedicated to environmental stewardship, working to conserve resources such as energy, water and raw materials while also reducing emissions and waste.

Climate impact mitigation and resource scarcity are key challenges facing society, ones for which we naturally accept our share of the responsibility. Through certified environmental management systems and targeted environmental measures, we work to minimize the environmental impacts of our activities.

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# Environmental stewardship

As a science and technology company with manufacturing operations, we utilize resources and materials that could have a potentially negative impact on the environment if not handled properly. To mitigate this effect, all our sites meet a strict set of environmental requirements.

A holistic approach is needed to minimize negative impacts on the environment and sustainably preserve resources in the long run. Intelligent environmental stewardship reduces resource use and lowers costs.

## Our principles

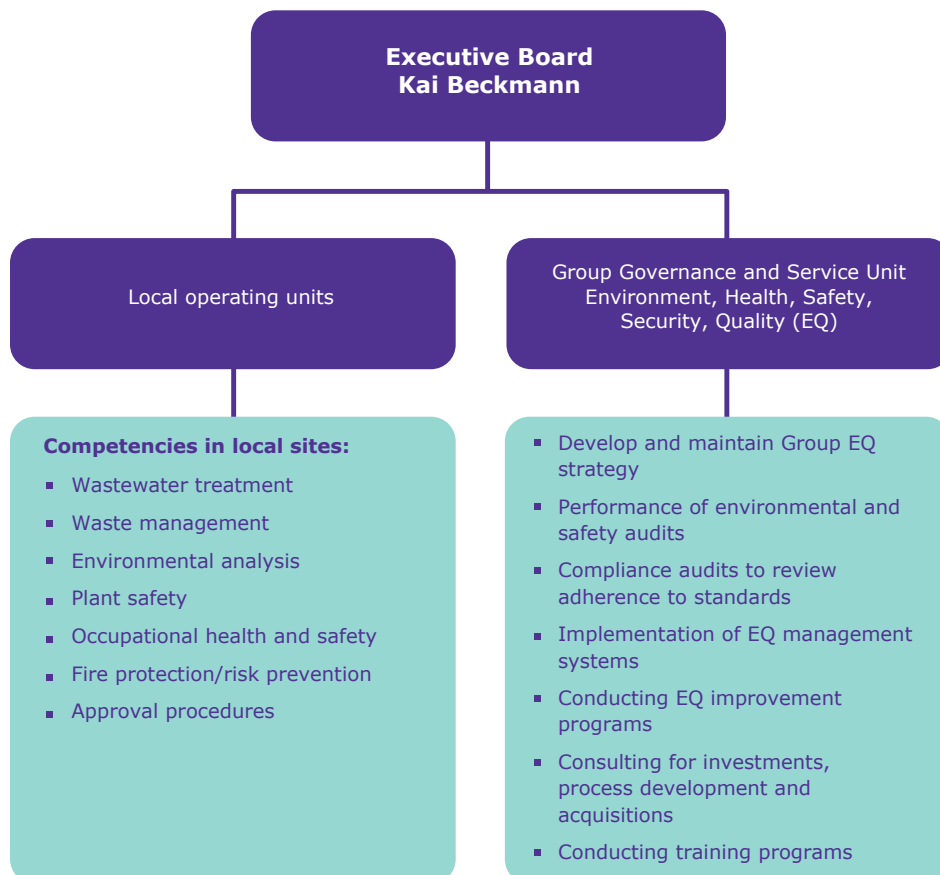
We continuously seek to reduce our environmental footprint, which requires us to utilize resources such as raw materials,

energy and water both sparingly and efficiently while also cutting emissions and waste.

## Clearly assigned responsibilities

Ultimate responsibility for environmental stewardship is borne by Kai Beckmann, Executive Board member and Chief Administration Officer. The Group function Environment, Health, Safety, Security, Quality (EQ) is in charge of steering all environmental measures Group-wide. At our individual sites, each site director is responsible for environmental stewardship as well as occupational health and safety at the operational level. At larger facilities, the site directors receive day-to-day support and advice from Environment, Health and Safety (EHS) managers, with EHS coordinators performing this role at smaller facilities.

## Our Group function EQ (Environment, Health, Safety, Security, Quality)



## Fundamental strategy for environmental sustainability

Our approach to environmental stewardship is built on our Corporate Environment, Health and Safety Policy, which we updated in 2016. This policy is now aligned more closely with the stipulations of the chemical industry's Responsible Care® Charter, as well as environmental management standard ISO 14001, and it emphasizes our management's responsibility toward environmental stewardship, health and safety (p. 70). Moreover, it addresses our suppliers (p. 89), encouraging them to adopt similarly high standards for environmental sustainability and safety. In doing so, our Corporate Environment, Health and Safety Policy complements the Responsible Sourcing Principles of our Group Procurement function.

The principles of our EHS policy are implemented through internal guidelines, standards and operating manuals. For instance, our Group EHS, Security and Quality Manual describes how environmental stewardship and occupational safety are organized across the company. We ensure compliance with all requirements through internal and external audits. Additionally, employees have the option of reporting compliance violations to Group Compliance (p. 11). In the 2015-2016 period, no significant violations of environmental laws or regulations were recorded within the company.

We regularly review and update our internal guidelines, standards and operating manuals. Following the 2015 acquisition of the U.S.-based life science company Sigma-Aldrich, all their existing EHS standards were reviewed and aligned with ours.

## ISO 14001 Group certificate

We manage our environmental sustainability efforts via an ISO 14001:2004 certified management system. Since 2009, our company has had a corresponding Group certificate, which means that all production sites with more than 50 employees must implement the requirements of the certificate. Smaller sites are not obligated to implement an ISO-

certified environmental management system. New sites must incrementally establish a corresponding environmental management system and obtain ISO 14001 certification. Every year, we contract a third party to perform a certification audit. Furthermore, we conduct internal surveillance audits to ensure compliance with our requirements.

## Progress

### ISO 14001 certification expanded

In 2015 and 2016, we passed all ISO 14001 surveillance audits. Seven Sigma-Aldrich sites already had ISO 14001-certified environmental management systems, which were transferred to our Group certificate in 2016. Our certificate now covers 57 sites worldwide. In 2017 and 2018, we intend to integrate 30 additional Sigma-Aldrich sites into the certificate.

All manufacturing facilities of AZ Electronic Materials, a company we acquired in 2014, have been ISO 14001 certified and integrated into our Group certificate since early 2015. Moreover, we have also incorporated all AZ sites into our internal audit program. Corrective measures have been taken to remedy any defects found.

### Switch to ISO 14001:2015

In September 2015, the International Organization for Standardization (ISO) introduced ISO 14001:2015, an updated version of this standard. Among other changes, ISO 14001:2015 more strongly emphasizes a supply chain approach. We have to adapt our environmental management system to reflect the new version by 2018. In 2015, we conducted internal audits to determine the extent to which we were already meeting the new requirements. In 2016, we then analyzed our individual sites in detail to see where changes still needed to be made. We expect the results in early 2017 and will use them to adapt our approach to environmental management.

# climate

Climate change is one of the most pressing challenges of the 21st century. Thus far, it has only directly impacted us to a minor extent. Nevertheless, because our operations generate greenhouse gas emissions, we intend to do our part to mitigate our impact on the climate. In view of burgeoning regulations and rising energy costs, climate impact mitigation is also becoming an increasingly smart investment.

## Our principles

### Doing our part

We are taking action to mitigate our impact on the climate. Our goal for 2020 is to reduce our direct greenhouse gas emissions (Scope 1) and indirect emissions (Scope 2) by 20% relative to the 2006 baseline. Scope 1 covers emissions that we produce ourselves, for instance by burning fossil fuels to generate power, while scope 2 pertains to emissions from the consumption of purchased energy, such as electricity or district heating. Across the globe, 37 of our sites account for roughly 80% of our greenhouse gas emissions, which is why we are focusing our efforts here.

Energy conservation represents an important component of our climate impact mitigation activities. By adapting and modernizing our technology, we are improving the energy efficiency of our R&D operations, our production processes and our buildings.

We are further lowering greenhouse gases by increasing our use of renewable energies. Moreover, we are also reducing emissions that stem directly from energy generation and manufacturing operations.

Our Group function Environment, Health, Safety, Security, Quality (EQ) is responsible for globally overseeing all climate impact mitigation measures (see Environmental stewardship (p. 77)). At our individual sites, operating units are responsible for implementing the actions and initiatives stipulated by EQ.

### Regulatory framework for climate impact mitigation

We are subject to a wide array of national and international energy and emissions regulations, such as the German Energy Conservation Act, the German Renewable Energy Sources Act and the European Union emissions trading system. For instance, EU Directive 2012/27/EU stipulates that we must establish energy management systems and regularly audit our energy consumption. The sites subject to these requirements are responsible for implementing them and furthermore undergo audits conducted by internal or external experts.

With the 2015 Paris Agreement on climate change now in place and phase four (2021-2030) of the EU emissions trading program due to start soon, we expect to see a tightening of greenhouse gas emission regulations. Going forward in phase four, we foresee having to purchase the emissions allowances that we're still mostly obtaining for free during phase three (2013-2020).

### Strategic approach to climate impact mitigation

In 2009, we launched our strategic Edison program to consolidate all our initiatives for improving energy efficiency and reducing process-related greenhouse gas emissions. Under Edison, our Group function EQ collaborates with a working group comprising representatives from all business sectors. Any site can propose a project. The working group assesses the proposals according to three criteria: 1.) the total absolute CO<sub>2</sub> savings, 2.) the potential cost savings, and 3.) the ratio of CO<sub>2</sub> savings to required spend.

### Internal standards and external certification

Our Corporate Environment, Health and Safety (EHS) standards on energy management and emissions from coolant ensure that energy and process-related emissions are managed consistently across the Group. In 2016, these standards were also implemented for Sigma-Aldrich sites. Site management conducts local audits at random to verify compliance with all EHS standards.

Efficient energy management plays a particularly important role in climate impact mitigation and is also increasingly important to our customers. With this and other reasons in mind, 13 of our sites decided to obtain ISO 50001 certification, the international standard for energy management, by the end of 2016. Further facilities are currently preparing for this certification process.

### Educating employees on climate impact mitigation

We encourage our employees to do their part to preserve the climate. We regularly report on our Group-wide climate impact mitigation activities in our employee magazine "pro" (p. 72) and in our employee newsletter, while also providing helpful information and tips on our Intranet. Moreover, we support employees who prefer greener modes of transport. For instance, we are constantly updating our pool of leased vehicles with more efficient models to reduce the average CO<sub>2</sub> emissions of our business car fleet by 30% by 2020, relative to 2013. We also provide further incentives in the form of the Jobticket (p. 81) for public transport and attractive deals for leased bicycles (p. 81).

## Switching to sea freight

In an effort to reduce greenhouse gas emissions resulting from the transport of our products, we utilize sea rather than air freight whenever possible. However, this is only an option for products that are not damaged by protracted transport times. At the same time, we cannot allow the quality of customer service to suffer due to extended transport times.

## Transparency for CO<sub>2</sub> emissions and energy consumption

Since 2008, we've been reporting in detail on our climate impact mitigation efforts as stipulated by the CDP (previously Carbon Disclosure Project). We track our greenhouse gas emissions in line with the Greenhouse Gas (GHG) Protocol, an internationally recognized standard, reporting on scopes 1 and 2, as well as parts of scope 3. Scope 3 includes other indirect emissions, such as the extraction and production of purchased materials, transport-related activities, waste disposal, and employee travel. Tracking scope 3 emissions is a rather complex undertaking. We track emissions from business trips and employee commuting, from waste management, and from the manufacture and transport of fuel.

Besides emissions, we also measure energy consumption at our sites. This does not, however, include energy use outside our field of activity, such as the production of our raw materials, as we do not have sufficient data available to perform these complex calculations.

## Progress

### Slight drop in energy consumption

In total, we used 2,253 gigawatt hours of energy in 2016, versus 2,256 gigawatt hours in 2015. Our energy intensity relative to sales totaled 0.150 kWh/€ in 2016.

### Emissions lowered despite growth

Despite growth in our operating business, we managed to reduce our greenhouse gas emissions by 10% relative to the 2006 baseline. In 2016, we emitted 715,000 metric tons of CO<sub>2</sub> equivalents, with 729,000 metric tons in 2015.

Between 2006 and 2016, we more than doubled our sales, which means that, relative to sales, our emissions have dropped significantly. Due to the previously mentioned

acquisitions, we set an interim goal for the sites of our Life Science business sector of lowering the greenhouse gas emissions of our former Merck Millipore business by 10% by 2015, relative to 2006. By the end of 2015, we had even managed to surpass this target by achieving a reduction of 11%.

## Hundreds of climate projects initiated

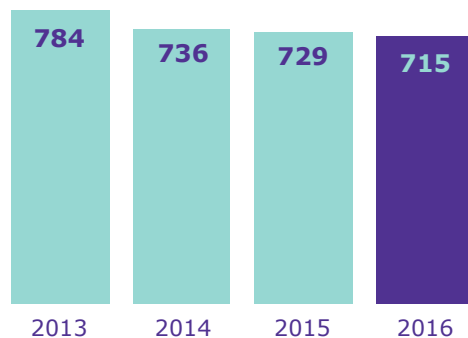
Through the approximately 270 Edison projects initiated since 2012, we aim to annually save around 94 metric kilotons of CO<sub>2</sub> in the medium term. Since the program's launch, these efforts have conserved around 82,000 MWh of energy in total. At nearly 64,000 MWh, electricity use accounted for the greatest savings. For 2017, 81 new projects have been approved, in the hopes of achieving additional savings of around 34,000 metric tons of CO<sub>2</sub> annually.

In 2015 and 2016, we carried out projects such as:

- Our site in Onahama, Japan is one of the highest energy consumers within our Group, requiring large quantities of steam for pigment production. In 2015, we therefore switched process steam generation for production from kerosene to natural gas combustion. In addition, our pigment kilns are now fired with natural gas instead of liquefied gas. These changes will reduce CO<sub>2</sub> emissions by approximately 3,200 metric tons per year. In 2016, we successfully replicated this change at other facilities. At our Shizuoka site, for instance, we switched from heavy oil to natural gas for steam generation while also revamping the boiler and conduit system. In doing so, this site cut back its CO<sub>2</sub> emissions from the manufacture of high-tech chemicals for the microchip and display industry by approximately 850 metric tons per year.
- Our production sites in Darmstadt and Gernsheim, Germany account for approximately 29% of our global energy consumption, which led us to invest roughly € 27 million in the construction of two state-of-the-art energy stations, one of which went online in 2014 and the other at the end of 2015. These energy stations provide our pharmaceutical production operations, pharmaceutical research facilities, chemical plants, and chemical labs with electricity, heating and cooling. The new installations will reduce our CO<sub>2</sub> emissions by around 2,500 metric tons per year.
- In Shanghai, China, we commissioned a new photovoltaic plant in 2015 that is lowering this site's CO<sub>2</sub> emissions by roughly 280 metric tons annually.

## Total greenhouse gas emissions (metric kilotons)<sup>1</sup>

(Scope 1 and 2 of the Greenhouse Gas Protocol)



<sup>1</sup> In line with the Greenhouse Gas Protocol, for all previous years (up to the 2006 baseline) the greenhouse gas emissions have been calculated based on the current corporate structure of the reporting year and retroactively adjusted for acquisitions (e.g. Sigma-Aldrich in 2015) or divestments of (parts of) companies, or for changes in emission factors (portfolio-adjusted).

### Green mobility: Jobtickets, leased bikes and subsidies

We offer our workforce in Darmstadt a "Jobticket", an annual subscription to use local public transportation for which we cover part of the cost. In 2016, more than 3,800 employees made use of this option. Since 2016, our people have also had access to an online tool that helps them organize carpools.

Our Life Science employees in the United States can charge their electric vehicles for free at special charging stations directly on site. Our Darmstadt facility introduced such charging stations in 2016. Individual sites in France and Ireland likewise offer this service.

As of January 2017, we further lowered the CO<sub>2</sub> emission rate for newly registered company cars from 150 g/km to a maximum of 135 g/km. At most of our German subsidiaries, we offer a subsidy of € 100 towards monthly lease payments to employees who voluntarily choose a greener car model. Relative to 2013, we have managed to decrease the CO<sub>2</sub> emissions of our company car fleet by 12%, and intend to expand this incentive to include all employees in Germany.

Our workforce in Darmstadt and Gernsheim also have the option of leasing a bike with payments coming out of their pre-tax income (bike4me). In 2017, we intend to offer this option to all employees in Germany.

Furthermore, our employees can also use the Call a Bike service throughout Germany at reduced prices to rent a bike for short periods of time. Deutsche Bahn, the German national rail company, is also setting up further rental stations all around our sites in Darmstadt. In support of this

initiative, we are sponsoring an additional 50 bikes in the city.

In the United States, too, we provide our people with financial incentives to live greener. For instance, they receive up to US\$ 1,000 in subsidies towards the construction of a private solar power unit and up to US\$ 100 towards an energy consultant for their private home. They are also eligible for as much as US\$ 3,500 towards the purchase of a hybrid or electric car, an incentive that has motivated more than 200 employees to switch to one of these types of vehicles.

### Reduction in transport-related CO<sub>2</sub> emissions

In 2016, we switched additional transport routes from air transport to sea freight. Our Performance Materials business sector is now shipping its products between Germany and Japan, as well as between Japan and Korea, by boat instead of plane. Our Life Science business sector has also switched transport between the United States and Argentina to sea freight. These changes are cutting our annual CO<sub>2</sub> emissions by a total of 300 metric tons.

### Positive rating from the CDP

In 2016, the CDP reworked its scoring methodology and now only gives one rating per company. The score incorporates more than just successes in and strategies for reducing greenhouse gas emissions. The CDP also assesses the ways in which companies are working to minimize the risks and consequences of climate change. The rating scale ranges from A to D-, with A being the top score.

According to this new methodology, we received an A- in 2016. As a Sector Leader for the DACH Region, we rank among the top 16% of companies in the Healthcare, Pharma & Biotech category in Germany, Austria and Switzerland. In

2015, when the CDP was still using the old evaluation model, our performance scored a C and our reporting was rated 98 out of 100 points, putting us in sixth place in the Healthcare category in Germany, Austria and Switzerland.

## Resource efficiency

Natural resources are growing ever scarcer, which makes it imperative for us to use raw materials as efficiently as possible and contribute to waste reduction. By conserving energy, water and materials, we are not only mitigating our impact on the environment, but are also lowering our costs.

We work continuously to reduce the environmental footprint of our products and even help our customers lower their own resource use, thus improving our competitive advantage.

### Our principles

#### Holistic approach to resource efficiency

Our holistic approach to resource efficiency helps us minimize our consumption of energy, water and materials while also maximizing resource reuse. Because we utilize the majority of resources for the manufacture of our products (p. 29), resource efficiency is a critical factor in product development and production processes. The measures required to accomplish this are an integral component of our approach to environmental stewardship (p. 77) and are organized by Environment, Health, Safety, Security, Quality (EQ).

#### Reducing resource use

Our manufacturing operations consume a great deal of energy, but our buildings likewise require energy in the form of electricity and heat. We are working to improve our energy

efficiency through a wide array of initiatives. Under our Edison program, for instance, we are investing in measures to boost energy efficiency, which form just one part of our commitment to the climate (p. 79).

We use water primarily for cooling, as process water and for exhaust air purification. Our water management (p. 84) approach combines water use reduction with wastewater treatment. Alongside climate impact mitigation, water management is a key focus of our environmental stewardship efforts.

We primarily use chemical and pharmaceutical raw materials for our manufacturing operations. Additionally, we also employ operating supplies and packaging materials such as folding boxes, glass bottles and ampules. Our waste and recycling (p. 82) management approach helps us efficiently utilize materials and maximize reuse.

### Progress

#### Higher material consumption

We utilized 330.6 metric kilotons of material in 2015 (excluding Sigma-Aldrich) and 798.1 metric kilotons in 2016 (including Sigma-Aldrich). We only track the weight of materials that are directly used in our pharmaceuticals and chemicals.

## Waste and recycling

Waste material contains valuable raw materials that can be reused in the production stream, which is why we consider it highly important to prevent or recycle as much of our waste as possible.

### Our principles

#### Preventing, recycling and disposing waste

We work to minimize the environmental impacts of our waste as far as possible and limit the loss of raw materials. This

means that we first attempt to prevent waste. However, this not always being feasible, we seek to recycle as much of our waste as possible. Waste that cannot be recycled is discarded in an environmentally sustainable manner in line with the most stringent waste disposal standards.

#### Waste management at Group and site levels

Waste management is part of our Group-wide ISO 14001-certified environmental management system. The Group function Environment, Health, Safety, Security, Quality (EQ),



which is in charge of environmental stewardship (p. 77), bears overall responsibility for waste management. As well as undergoing external certification, we also conduct internal Corporate Environment, Health and Safety audits to review our waste management approach and programs. We regularly inform and educate our local EHS managers and site directors on various waste disposal issues in an effort to ensure Group-wide compliance with our environmental standards.

Our Group-wide EHS standard "Waste Management" provides a consistent framework for waste management across all our sites, defining organizational structures and minimum requirements. In line with this standard, all facilities document their waste by type and quantity, reporting this data to EQ.

### The Merck Waste Scoring System

At Merck, we use several methods for recycling and disposing of waste. In an attempt to better manage our various waste streams, in 2016 we developed the Merck Waste Scoring System, which is based on a five-level waste hierarchy:

1. Waste prevention
2. Materials recycling
3. Waste-to-energy
4. Thermal disposal
5. Landfill

In terms of the resource footprint of the waste, it progressively worsens from level one through level five. Waste prevention is the best, most desired form of waste management as it avoids using raw materials and prevents negative environmental impacts. Materials recycling allows raw materials contained in the waste to be recovered. Depending on the waste type, this process saves significant quantities of raw materials and energy even though it somewhat reduces product quality (downcycling). Waste-to-energy is the conversion of non-recyclable waste materials into usable heat, electricity, or fuel through a variety of processes. Power generation through waste incineration plants, which reduce the use of fossil fuels, is a perfect example. Waste for disposal is either incinerated or sent to landfills, making it impossible to recover raw materials.

Each individual type of waste – plastic, paper, metal, glass, hazardous waste, etc. – requires individual evaluation.

### Merck Waste Score as a performance indicator

In 2016, we created the Merck Waste Score to help us quantify the resource conservation target for our waste streams and compare the amount of waste our sites are producing. Under this system, each site's waste is allocated a score for each of the five steps of the waste hierarchy. This score is

then multiplied by the percentage that results from dividing the waste quantity of the given disposal method by the waste quantity. The sum of the scores of each level provides the total Merck Waste Score.

In 2017, we plan on using this system to assess waste disposal Group-wide. This assessment will help us define a target for the Merck Waste Score and gauge the progress of our waste management efforts.

### Responsibility for entire waste disposal process

As a generator of waste, we are responsible for the final disposal of our waste products and therefore choose our service providers with the utmost care, contractually stipulating disposal requirements. Each of our vendors must be able to prove that they have properly discarded our waste. We conduct regular audits to ensure that our waste is disposed of in an appropriate fashion, especially in the case of hazardous substances.

### Progress

#### Decline in waste generated

The amount of waste we produced in 2016 dropped to 254 metric kilotons, versus 317 metric kilotons in 2015. This sharp decrease is primarily attributable to lower quantities of construction and demolition waste, which continued to account for the majority of our total waste – 30% in 2016 and 49% in 2015. In particular, the remodeling of our Group headquarters in Darmstadt has generated large quantities of such waste material.

#### Employees help separate trash

At our site in Molsheim, France, we implemented a recycling system over five years ago and have been continuously refining it ever since. This facility performs function testing and lab tests that regularly produce large quantities of waste. In response, our local EHS officers have developed a trash separation system, conducted training and enhanced the necessary processes. Today, employees at this site separate up to ten different types of waste, allowing more than five metric tons of plastic to be recycled per year.

#### 60% less solvent used

In the 2015-2016 period, our site in Shizuoka, Japan started using special plastic liners in our containers for specialty chemicals. This change considerably reduced the required amount of an acetic ester derivative that had previously been utilized as a solvent to clean the containers. As a result, this facility is saving 70 metric tons of this solvent per year, representing a 60% reduction of the acetic ester derivative used for washing processes at this site.



### Shizuoka reduces filter waste

In 2015, we switched the multi-step filter process for photoresists at our Shizuoka site in Japan to a single-step process. Instead of requiring several filters, the process now uses only one, thus decreasing filter waste by 70%. In 2016, we introduced the single-filter process at our facilities in Hsinchu, Taiwan, and Suzhou, China, where we eliminated 50% of our filter waste at each site. We are currently investigating whether we can implement the new filter process at other facilities as well.

### Recycling process saves on solvent

At our facility in Kaohsiung, Taiwan, we implemented a recycling process for the solvent diisopentyl ether in 2012, which we have since worked to continuously improve. Thanks to this effort, we recycled 88% of the solvent used in 2016. Within four years, we thus saved approximately 200 metric tons of solvent waste and more than € 2 million. We have introduced a similar recycling process at Kaohsiung for the solvents acetone and pentane.

## Water Management

An increasing number of regions across the globe are facing potable water supply issues. At our sites, we too are dependent on a reliable supply of water that meets certain quality standards. We use water in our manufacturing operations as process water as well as for functions such as cooling and exhaust air purification, which makes sustainable water management a key focus of our environmental stewardship (p. 77). Because our wastewater may contain traces of heavy metals or pharmaceutical active ingredients, protecting water as a resource is one of our primary considerations.

### Our principles

#### Reducing use, minimizing impacts

We seek to lower our water use, especially in those regions where water is growing ever scarcer. At the same time, it is our responsibility to minimize the impact of our wastewater across all our sites.

The Group function Environment, Health, Safety, Security, Quality (EQ), which is in charge of environmental stewardship, bears overall responsibility for water management. At our individual sites, technicians collaborate closely with our Environment, Health and Safety managers on implementing measures to reduce water use and furthermore receive regular training from EQ.

#### Sustainable water management

We systematically analyze our water use data utilizing tools such as the Water Risk Filter of the World Wide Fund For Nature (WWF) and the Aqueduct Water Risk Atlas of the World Resources Institute (WRI). These tools help us determine whether a site is located in areas of high water stress, meaning regions where water consumption exceeds the supply. At the beginning of 2016, we set the goal of implementing a sustainable water management system at sites with high consumption levels by 2020.

For our sustainable water management efforts, we use an assessment tool of the European Chemical Industry Council (CEFIC) to evaluate water management practices and progress at our sites. Based on this assessment, our facilities draft a list of steps that need to be taken and implement them one at a time.

But we also encourage efficient water management at facilities in areas of low or moderate water stress, which is why we are continuously expanding our best practice sharing platform for water management projects. Through this medium, our EHS officers can share ideas and lessons learned.

#### Reducing water use

Sites in areas of high water stress must transparently report their water use and identify the process steps that require a particularly high amount. We then define measures to help our individual facilities reduce their water use.

Our production sites in Mexico City (Mexico), Mollet del Vallès (Spain), Kankakee, IL (USA), and Norwood, OH (USA) are located in areas of high water stress and consume more than 30,000 cubic meters of water per year. Furthermore, our facilities in Savannah, GA (USA), Hsinchu (Taiwan) and Taoyuan (Taiwan) are at increased risk due to the local groundwater shortage or seasonal water scarcity. At each of these sites, we aim to reduce water use by 10% by 2020, relative to the 2014 baseline.

#### Water Protection standard

Our processes and responsibility for clean wastewater are defined in our EHS Water Protection standard, which is based on the commitments we've made under Responsible Care®. In line with this global initiative, all our sites are required to measure and assess the risks and impacts of the hazardous substances in their wastewater.

We regularly conduct internal audits to check compliance with our EHS Water Protection standard. Our Group-wide ISO 14001-certified environmental management system (p. 77) also covers aspects of water management, with a greater focus on manufacturing sites than administrative facilities.

### Minimizing residues

We seek to minimize the residues in our wastewater. In support of this goal, all our sites develop and implement a water pollution response plan.

Our EHS Water Protection standard particularly focuses on trace residues that impact the environment. For instance, we are optimizing production and purification processes to reduce the amount of pharmaceutical active ingredient

residue in our wastewater as much as possible. All pharmaceutical manufacturing facilities also have wastewater treatment plants in place and regularly measure the composition of their wastewater.

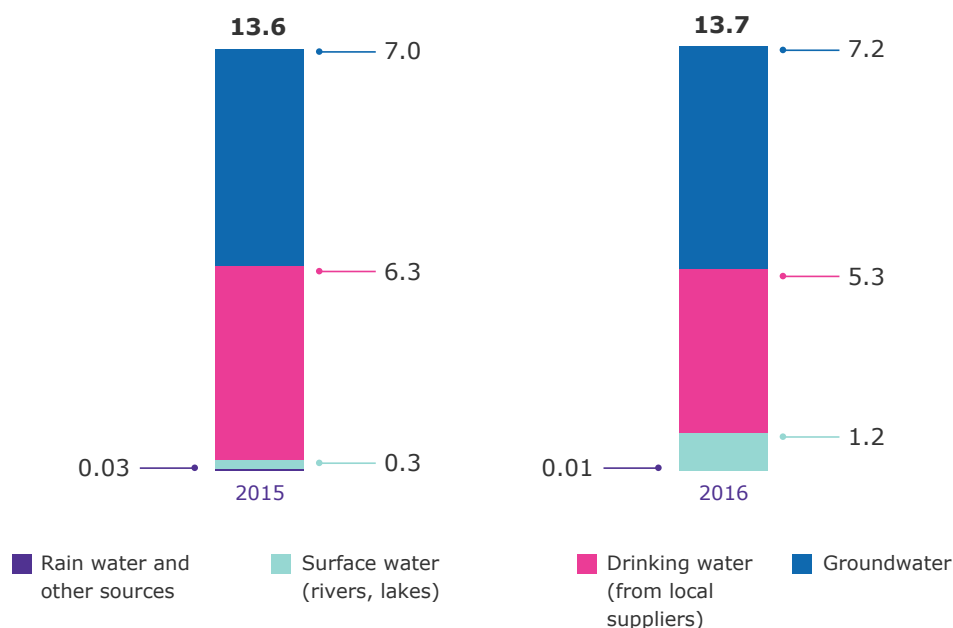
### Progress

#### Water from our own sources

For the most part, we draw groundwater from our own wells and drinking water from local suppliers. We never do anything to compromise sensitive water sources.

In the 2015-2016 period, our water use was broken down as follows:

#### Water consumption (millions of m<sup>3</sup>)



For the most part, our cooling water for production processes runs in a circular system. Depending on regulatory standards, we sometimes use fresh water in a once-through cooling system if it improves our energy footprint. For certain applications, we treat production wastewater and reuse it. In 2015, we reused 23.0 million cubic meters of water, with 22.7 million cubic meters reused in 2016.

### Water stewardship

At the end of 2015, we developed a new process that enables bismuth oxychloride products to be manufactured at our site

in Savannah, GA (USA) without the use of nitrates. Thanks to this innovation, we no longer utilize hazardous materials such as nitrate and nitric oxide and have reduced water usage by approximately 85%, meaning 21,500 cubic meters per year. At our Hsinchu site in Taiwan, we started recycling HVAC water condensate in 2015, enabling us to reduce water usage by 5% per year in the 2015-2016 period. In 2016, we thus saved more than 1,300 cubic meters of water.

Our facility in Kankakee, IL (USA) also uses a great deal of water. In 2015 and 2016, we achieved approximate savings of 30% by optimizing our own fresh water treatment plant.

We also implement measures to minimize our negative impacts at sites that are not located in high water stress regions. Our manufacturing facilities in India abide by a zero discharge policy that requires used water to first be treated before being allowed to drain back into the soil. Furthermore, our Goa site collects rain water and lets it seep back into the soil as well, a process that has enabled us to stop the water level there from sinking further.

#### China: Simultaneously reducing energy and water

A project at our site in Suzhou, China shows how the consumption of different resources can be interconnected. Through a single measure, we have cut down the water and energy used for recycling a solvent mixture by distillation. We leave a portion of the water in the solvent mixture that would otherwise have to be discarded as wastewater. In doing so, we have reduced wastewater by nearly 633,000 cubic meters per year, which represents a 66% decrease in wastewater. When customers reuse the solvent mixture, they need not add more water, creating additional water savings. This change furthermore allowed us to save more than 390,000 kilowatt-hours of electricity (around 22% less)

and approximately 263,000 cubic meters of liquefied gas (around 57% less).

#### Wastewater continuously monitored

In 2015 and 2016, our wastewater management activities were continuously monitored and reviewed in line with our Water Protection standard. As such, 77 internal EHS audits were conducted, as were 18 external ISO 14001 certification audits.

In 2016, we generated 12.1 million cubic meters of wastewater, with 11.8 million cubic meters in 2015. The wastewater generated at our Darmstadt site is treated in our state-of-the-art treatment plants before being fed into Schwarzbach-Ried Creek, a tributary of the Rhine River. In 2016, we discharged a volume of water representing approximately 5% of the average annual discharge of Schwarzbach-Ried Creek. We continuously work to meet the increasingly stringent quality regulations set forth by law, regularly coordinating our efforts with the respective authorities. In the 2015-2016 period, we did not discharge any other wastewater into bodies of water.

## plant and process safety

The safety of our plants and processes is a key element of our environmental sustainability efforts. This approach allows us to ensure the safety of our workforce as well as the people in the vicinity of our sites. Functional safety systems also help minimize production errors, which in turn reduces the risk of economic losses.

### Our principles

#### Preventing disruptions

We seek to eliminate as many manufacturing hazards as possible to prevent workplace accidents, production outages, and chemical leaks. We attempt to detect technical defects before they have a chance to cause damage. By providing training for our employees, we prevent human errors as much as possible.

#### Group-wide organization

Our Group function Environment, Health, Safety, Security, Quality (EQ) is in charge of environmental stewardship and safety worldwide, and oversees plant and process safety at Merck. At the operational level, responsibility for plant and process safety falls to our individual sites and their EHS managers. Our local EHS organizations report to and work hand in hand with EQ.

#### Safety requirements

All sites are subject to the same requirements for plant and process safety set out by our Group-wide EHS Plant and Process Safety standard, which describes the safety rules for all production plants and warehouses. These requirements encompass the entire life cycle of a plant, from cradle to grave. Before we commission a plant, we draft a safety concept that is continuously updated until the facility is decommissioned. This concept contains an overview of potential risks and the corresponding protective measures. In the 2015-2016 period, we started implementing our Plant and Process Safety standard for Sigma-Aldrich sites as well, with completion expected in the course of 2017.

#### Minimizing risk

Our Group-wide EHS Spillage Control standard governs the handling of hazardous materials and stipulates organizational measures to prevent toxic substances from spilling or leaking during storage and transport. In addition to this standard, our Risk Management Process guides all our sites in identifying and assessing risks. As needed, this process can be used to develop and implement measures to minimize such risks. In 2016, we conducted our Group Procedure Hazard and Operability Study, which clearly defined the individual responsible for identifying potential hazards during a project

as well as the manner in which risks should be identified and documented.

### Training employees

The safety of our plants and processes is predicated on the successful interaction between man and machine, which is why it's crucial for us to educate our employees and provide them with regular training. Our internal continuing education programs for site, production, engineering, and EHS officers also cover plant and process safety. Likewise, newly hired EHS managers are trained in plant and process safety during their onboarding.

### Legislative changes

The EU Directive adopted in 2012 on the control of major accident hazards involving dangerous substances (aka Seveso III) was transposed into German law at the end of 2016. In 2017, we will therefore be updating existing processes and documents on the assessment and communication of potential hazards in production plants and warehouses.

### Making safety measurable

Through our EHS performance indicators, we make it possible to measure safety and thus identify opportunities for improvement. We track EHS performance indicators at all production and warehouse facilities, as well as at major research sites such as Chilworth (UK) and Billerica, MA (USA). In doing so, we record both accidents and near-accidents. We investigate each individual incident before devising appropriate countermeasures in an effort to prevent such accidents in the future.

For instance, since 2013 we have been tracking the EHS Incident Rate, an indicator that synthesizes the following four categories of data:

- the number of workplace accidents involving Merck employees and contractors who work at our sites
- environmentally relevant incidents as defined by the European Chemical Industry Council (CEFIC) and the German Chemical Industry Association (VCI), for instance product spills
- the activation of operational safety precautions that do not have an adverse impact on people and the environment, such as a preemptive systems shutdown

- deviations identified during external reviews and audits

The calculation of the EHS Incident Rate includes the number of incidents and the severity of the accident relative to the number of man-hours worked. The lower the EHS Incident Rate, the safer the site is.

### Learning from incidents across all sites

It is important to share best practices and lessons learned, an approach that enables all our production sites to learn from the incidents at other facilities and thereby implement preventive measures. For instance, once a month, site directors and EHS managers participate in safety leadership calls to share new lessons learned.

## Progress

### Steady decline in accident rate

Our EHS Incident Rate (EHS IR) indicates that the number of accidents within our company is steadily sinking. In 2015, our EHS IR was 4.3, with 3.4 in 2016.

### Spills without significant adverse effects

Across all production, research and storage sites, we recorded a total of 32 incident-related spills in 2015 and 41 incident-related spills in 2016, none of which led to significant environmental pollution.

### Taking countermeasures after a fire

In February 2015, a filter fire in a pigment production facility in Gernsheim led to damage costing millions of euros. We investigated the incident and, as a preventive measure, installed a temperature monitoring system for the filter inner area of all pigment production lines at the site. We are now better equipped to promptly detect when the production lines grow unusually hot.

### Training new personnel

In 2016, 25 new employees, primarily from Sigma-Aldrich, took part in our onboarding process, where they received training on many topics, including plant and process safety. The U.S.-based EHS managers from Sigma-Aldrich participated in a separate onboarding process in the United States.

# Biodiversity

The increasing loss of biodiversity is a global challenge that impacts our company as well. After all, we depend on ecosystems for natural resources such as raw materials. A prime example from our Healthcare business sector is comfrey root extract, which is used in our Kytta® pain relief cream. We therefore have a vested interest in preserving and promoting biodiversity.

## Our principles

### Holistic approach to conserving biodiversity

Our wide array of environmental sustainability efforts, such as water management (p. 84) and climate impact mitigation (p. 79), directly contribute to the conservation of biodiversity. Representing part of our commitment to environmental stewardship (p. 77), our measures to protect biodiversity are overseen by our Group function Environment, Health, Safety, Security, Quality (EQ).

Across all our sites, we take into consideration the unique features of the ecosystems in our immediate vicinity with the goal of minimizing our direct impacts as far as possible.

### Designing with biodiversity in mind

Substances that could compromise biodiversity should not be discharged into the environment, which is why we design and operate our plants in accordance with our Group-wide safety and environmental requirements. For instance, our Corporate Environment, Health, and Safety (EHS) standards define the manner in which we manage waste (p. 82) and wastewater (p. 84) treatment as well as improve plant safety (p. 86).

In designing new sites and plants, we always include our EHS unit to ensure that ecological aspects are also taken into consideration.

### Minimizing surface sealing

Unsealed surfaces represent an important habitat for plants and animals. At our facilities, however, we are required to seal certain surfaces to minimize the risk of chemicals ending

up in the ecosystem. Our goal is to increase the percentage of unsealed surfaces insofar as safety requirements permit.

### Environmental risk assessment for acquisitions

Our production sites are located in established industrial and commercial zones.

Before acquiring a company, we first investigate ecological risks, taking into consideration information from public sources such as neighbors and non-governmental organizations (NGOs). The results of the investigation influence whether we decide in favor of the acquisition. Most recently, we conducted such risk assessments for the acquisitions of AZ Electronic Materials and Sigma-Aldrich.

### Implementing the Nagoya Protocol

The Nagoya Protocol is an international supplementary agreement to the UN Convention on Biological Diversity (CBD). Its aim is to implement one of the three objectives of the CBD, namely the fair and equitable sharing of benefits arising from genetic resources, with the other two convention objectives being the conservation of biological diversity (or biodiversity) and the sustainable use of its components. In October 2015, the Nagoya Protocol was transposed into German law. We are currently reviewing our processes in preparation to implement the new legislation within our Life Science business sector.

## Progress

### Biodiversity conservation at our sites

Our Darmstadt site is a prime example of our commitment to preserving biodiversity. Since 2016, we've been conducting an assessment of our facilities in both Darmstadt and Gernsheim to evaluate their nature conservation efforts. The results will help us develop an action plan for improving the surrounding ecosystem for plants and animals. 30% of the premises (0.4 square kilometers) have already been greened. In 1995, we developed a green open space concept for our Darmstadt site, while a 2008 agreement with the city of Darmstadt stipulates how nature conservation is to be integrated into the land use of our site.