Innovation

Around 10,700 employees worldwide in research and development
€1,884 million spent on research and development
3,000 projects in the research pipeline

Innovations based on effective and efficient research and development are an important growth engine for BASF. Our employees work in interdisciplinary teams on innovative processes and products for a sustainable future. This is how we ensure our long-term business success with chemistry-based solutions for almost all sectors of industry.

A growing need for energy, food and clean water, limited resources and a booming world population – reconciling all these factors is the greatest challenge of our time. Innovations based on chemistry play a key role here, as they contribute decisively to new solutions.

We have set ourselves ambitious goals: In 2015, we aim to achieve sales of around €10 billion and an EBITDA of around €2.5 billion with new and improved products or applications that will have been on the market for less than five years. In 2020, we want to increase our sales to around €30 billion and EBITDA to around €7 billion with innovations that will have been on the market for no longer than ten years.

Goals for sales and EBITDA with innovations (in billion €)

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<thead>
<tr>
<th></th>
<th>2020</th>
<th>2015</th>
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<tbody>
<tr>
<td>Sales</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>EBITDA</td>
<td>2020</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td>2.5</td>
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1 Pertains to innovations then on the market for less than ten years
2 Pertains to innovations then on the market for less than five years

Our innovative strength is based on our global team of highly qualified employees with various specializations. In 2014, the number of employees involved in research and development rose to around 10,700 (2013: 10,650). The central research units Advanced Materials & Systems Research, Biological & Effect Systems Research, Process Research & Chemical Engineering, and BASF Plant Science are our knowledge and competence centers. Together with the development units in our operating divisions as well as BASF New Business and BASF Venture Capital, they form the core of our global Know-How Verbund.

Global network in science and industry

- Network with more than 600 excellent universities, research institutes and companies
- Network for Advanced Materials Open Research initiative established in Asia
- Foundation of California Research Alliance by BASF

Our global network with more than 600 excellent universities, research institutes and companies is an important part of our Know-How Verbund. We work with them in many different disciplines in order to achieve our ambitious growth targets. In 2014, we established the “Network for Advanced Materials Open Research” initiative together with seven leading universities and research institutes in China, Japan and South Korea. Together, we aim to develop new materials for a wide range of applications. The initial focus is on products for the automotive, construction, detergent and cleaner industries, as well as the water and wind energy sector. In addition, we have founded the “California Research Alliance by BASF” together with major universities on the U.S. West Coast. This multidisciplinary research institute focuses on new inorganic materials and their applications, bioscience, and related technologies.

Strategic focus

- Forward-looking project portfolio
- Stronger customer and market orientation
- Worldwide presence and expansion of research and development centers
- Research competencies pooled into three global platforms

Our research pipeline comprised approximately 3,000 projects in 2014. We increased our spending on research and development by €35 million to €1,884 million (2013: €1,849 million); the operating divisions were responsible for 79% of total research and development expenditures. The remaining 21% was allocated to cross-divisional corporate research, such as research on the growth and technology fields.

For a multiyear overview of research and development expenditures, see the Ten-Year Summary on page 235.
Innovations based on chemistry require market-oriented research and development that is sharply focused on the needs of our customers. In order to bring promising research ideas even faster to market, we regularly assess our projects according to a multistep process. BASF New Business plays a central role in the search for new business areas. It identifies trends and future markets at an early stage, turning attractive topics into growth fields.

Another vital factor for our success is a global research and development presence. We continued to broaden our activities in 2014, especially in Asia. By expanding our Innovation Campus Asia Pacific, we are further boosting the regional research capacities for new materials and systems. We are also expanding business areas like formulations and chemical process engineering. In Mumbai, India, we opened a global research and development center that focuses on organic synthesis, process development, formulation and crop protection research, and molecular modeling. We will also work on innovations for the electronics industry at our new Electronic Materials Research and Development Center Asia Pacific in Suwon, South Korea, which was inaugurated in 2014.

We aim to keep strengthening our research and development activities in Asia as well as in North and South America. Starting January 2015, we are pooling our research expertise into three global platforms surrounding the topics of chemistry, materials and bioscience, each headquartered in a region significant for us: Europe, Asia Pacific and America. We plan to conduct half of our research and development activities outside of Europe by 2020. This increased presence outside Europe creates new opportunities for fortifying and expanding customer relations and scientific collaborations, strengthening our R&D Verbund and making BASF an even more attractive partner and employer in the regions.

The number and quality of our patents attest to our power of innovation and long-term competitiveness. We filed around 1,200 new patents worldwide in 2014. For the sixth time in succession, we headed the rankings in the Patent Asset Index in 2014 – a method which compares patent portfolios industry-wide. This once again underscores BASF’s power of innovation.

**Research focus areas**

- Chemistry-based innovations play important role in answering questions of the future
- Growth fields with attractive sales potential in 2020
- Technology fields provide the basis for developing our growth fields

In order to develop future business areas for BASF, we have defined growth and technology fields for which we expect high sales potential in 2020. These research focus subjects are derived from the three major areas in which chemistry-based innovations will play a key role in the future: resources, environment and climate; food and nutrition; and quality of life. We regularly review the attractiveness of these growth and technology fields for BASF and adjust our portfolio as necessary.

### Research focus areas: growth and technology fields

<table>
<thead>
<tr>
<th>Global needs</th>
<th>Customer industries</th>
<th>Growth fields</th>
<th>Technology fields</th>
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<tbody>
<tr>
<td>Resources, Environment and Climate</td>
<td>Transportation</td>
<td>Batteries for Mobility</td>
<td>Materials, Systems &amp; Nanotechnology</td>
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<td></td>
<td>Agriculture</td>
<td>Enzymes</td>
<td>Raw Material Change</td>
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<td></td>
<td>Construction</td>
<td>E-Power Management</td>
<td>White Biotechnology</td>
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<tr>
<td>Food and Nutrition</td>
<td>Energy and Resources</td>
<td>Functional Crop Care</td>
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<tr>
<td>Quality of Life</td>
<td>Consumer Goods</td>
<td>Automotive Lightweight Composites</td>
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<td></td>
<td>Electronics</td>
<td>Organic Electronics</td>
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<td></td>
<td>Health and Nutrition</td>
<td>Plant Biotechnology</td>
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<td>Heat Management for Construction</td>
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<td>Water Solutions</td>
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<td>Wind Energy</td>
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Growth fields – examples

Innovative mobility concepts such as electromobility require batteries that are high-performance, affordable and safe. Therefore, in the Batteries for Mobility growth field, we are researching important system components of a battery, such as new cathode materials with a higher energy density and improved cost-benefit profile, and electrolytes for increased lifespan in lithium-ion batteries. In 2014, we expanded our research and development facilities in Beachwood, Ohio, and Amagasaki, Japan, where we will explore new cathode materials and improved electrolyte systems in the future. In order to better understand battery materials and stimulate new ideas, we work together with renowned scientists worldwide in our “Research Network Electrochemistry and Batteries.” We decided in 2014 to continue the university network, which was established in 2010, for another five years.

The growing world population's increasing demand for food requires additional solutions for healthier plants and higher yields that supplement conventional crop protection. This is why we research new products in the Functional Crop Care growth field that, for example, improve plant growth, better protect seeds, and help plants use scarce resources like water and nutrients more efficiently. Farmers all over the world mainly employ urea-based fertilizers in order to ensure that plants are supplied with enough nitrogen. However, some of the nitrogen contained in these fertilizers is lost as gaseous ammonia. Limus® can greatly reduce these losses. Thanks to its special formulation, this product also enables better storage of urea-based fertilizers. Limus® guarantees farmers both efficient fertilizer application and higher yields.

One of our projects in the Automotive Lightweight Composites growth field is the search for innovative materials and material systems that can be used to manufacture load-bearing components, such as the frame or passenger compartment, out of fiber-reinforced plastic. We are developing composite systems based on epoxy, polyurethane and polyamide resins. Carbon fibers lend themselves particularly well to reinforcement materials thanks to their high rigidity. In addition to developing the materials themselves, we are also adapting composite systems to the automotive industry's new manufacturing processes in order to make their transfer into large-scale production economically viable.

Technology fields

Various cross-sectional technologies provide the basis for developing our growth fields. We have grouped these into three technology fields: Materials, Systems & Nanotechnology, Raw Material Change and White Biotechnology.

The challenges of the future require intelligent solutions based on new systems and functional materials, which means that formulation and application expertise is increasing in significance. In the Materials, Systems & Nanotechnology technology field, BASF researchers work for example on new color filters that can be used in laptop and computer monitors as well as television screens. Irgaphor Red® S 3621 CF, BASF's new red pigment, ensures especially high image quality in liquid crystal displays. Thanks to its tiny particles that are less than 40 nanometers in size, light is less scattered in the color filter. The viewer therefore sees a very sharp image with clear colors and high contrast.

In the Raw Material Change technology field, we are searching for alternatives and supplements to crude oil as a raw material for the chemical industry. With natural gas, carbon dioxide and renewable resources, we aim to expand the raw material basis of our value chains in the long term. To do so, we use catalysts that make many chemical reactions more cost-effective, more environmentally compatible, or in some cases even possible. In the BasCat joint laboratory at the Technical University (TU) of Berlin, we and our partners seek to gain fundamental knowledge on activating less reactive molecules in order to accelerate the development of industrial catalysts in the long term. We started operations at the new BasCat laboratory building on the TU Berlin campus in 2014.

In the technology field White Biotechnology, we are researching methods and techniques for creating chemical and biochemical products in an efficient and resource-saving manner. Fermentation and biocatalysis increasingly represent competitive alternatives to chemical processes. Our researchers are working on new enzymes for technical applications that use molecular biological methods to improve the applications’ properties. Furthermore, they optimize fermentational production processes in order to produce enzymes on a large scale at high yield.

For more on research and development, see basf.com/innovations
Innovations in the segments – examples

Innovations are an important success factor for BASF’s long-term growth. In developing new products, we look at the needs of our customers as well as at market trends, and take advantage of the opportunities arising from the BASF Verbund’s value chains. Through innovative production processes, we aim to expand our competitive ability. We never stop improving our existing products, applications and processes. We view sustainability as an opportunity, since we use chemistry to create value for customers and society.

Performance Products: We launched Styrofan ECO® 7623, our newest water-based polymer dispersion, on the market in 2014. It imparts excellent flow properties and adhesion to repair mortars and floor screeds, and increases strength and abrasion resistance, as well. Styrofan ECO® 7623 meets the respective industries’ most stringent formaldehyde and ammonia emission standards for building materials, making it especially environmentally friendly.

With our innovative portfolio of SAVIVA® superabsorbents, producers of baby diapers, adult incontinence products and feminine hygiene articles can reduce raw material consumption and increase the comfort of their products. Droplet polymerization allows us to produce a round particle shape that results in an especially soft feel. Liquid is rapidly absorbed and distributed, keeping the skin pleasantly dry. The development of this pioneering technology makes superabsorbents even more efficient, enabling the creation of products like thinner and more comfortable diapers.

Trace elements in animal feed are essential in livestock farming. For example, they strengthen immune function, promoting the animals’ welfare. Our new, globally launched glycinate product line comprises organic compounds with copper, iron, manganese and zinc. Their high degree of bioavailability means that trace elements can be absorbed especially readily from feed. Furthermore, their excellent water solubility allows BASF glycinites to be easily added to drinking water. The animals are thus optimally provided with important trace elements, and the environment benefits from fewer excreted trace elements.

Paper and cardboard food packaging is coated with barrier materials to protect food from outside influences and keep, for example, water and grease from leaking out. BASF’s Epotal® product line comprises water-based barrier dispersions to efficiently coat various types of packaging. In South America, one of our biggest customers has been using Epotal® DS 2013 in their paper production as a liquid barrier for frozen food cartons since the middle of 2014. Epotal® DS 2013 is partly composed of renewable materials, can be easily recycled and is especially easy for customers to use.

Industrial and municipal wastewater treatment plants can be operated more efficiently and effectively with Zetag® ULTRA, our new range of flocculants. Zetag® ULTRA’s highly effective binding capability enables advanced dewatering performance compared with conventional flocculants. The higher proportion of cake solids in the dewatered sludge benefits the environment, as less energy is required for transportation, disposal and incineration. This has a positive impact on the treatment facility’s carbon footprint.

Expenditure on research and development by segment

<table>
<thead>
<tr>
<th>Segment</th>
<th>Expenditure 2014 (€ million)</th>
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<tbody>
<tr>
<td>Chemicals</td>
<td>10%</td>
</tr>
<tr>
<td>Performance Products</td>
<td>19%</td>
</tr>
<tr>
<td>Functional Materials &amp; Solutions</td>
<td>20%</td>
</tr>
<tr>
<td>Agricultural Solutions</td>
<td>27%</td>
</tr>
<tr>
<td>Oil &amp; Gas</td>
<td>3%</td>
</tr>
<tr>
<td>Corporate research, Other</td>
<td>21%</td>
</tr>
</tbody>
</table>

Chemicals: We have added a new product to our comprehensive range of amines: methyl diaminocyclohexane, which we market under the brand name Baxxodur® ECX 210. As a hardening agent in epoxy systems, Baxxodur® ECX 210 has proven valuable in, for example, the manufacture of wind turbine rotor blades and layering systems for industrial flooring and bridges. Baxxodur® ECX 210 is more efficient and can be processed for a longer period of time than comparable products.

Succinity GmbH, our joint venture with Corbion Purac, has been producing succinic acid out of renewable resources since 2014. The highly efficient process, based on sugar, starch or glycerin, binds carbon dioxide, reducing the formation of carbon dioxide by 60% compared with petrochemical processes. Bio-based succinic acid is therefore an economically and ecologically viable alternative to conventional succinic acid for our customers. Succinic acid is highly versatile and can be used, for example, in the production of bioplastics, solvents, polyurethanes and plasticizers.

Our chemical solutions help the highly competitive lumber industry further improve their products’ properties and reduce costs. For example, we have been able to enhance our Kaurit® glues so that wood can be worked into fiberboard even more efficiently and reliably, even with varying degrees of moisture content. As a result, our customers benefit from a higher level of process reliability and greater plant throughput.

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Functional Materials & Solutions: High ozone levels present a major challenge to many cities around the world. This is why we developed PremAir®, a patented catalytic coating for automotive radiators. As air flows over the radiator, PremAir® converts the ground-level ozone – the main component of smog – into oxygen. Our innovation, PremAir® NXT, is especially designed for use with today’s smaller automotive radiators. It can achieve even higher ozone conversion performance than the standard PremAir® coating over the lifetime of the vehicle. This helps automobile manufacturers meet the challenging California LEV III and U.S. Tier 3 emissions requirements and improves air quality for us all.

With MasterSphere®, we provide the construction industry with an utterly novel solution for making concrete more resistant to frost and dew. Around 50 external factors must be monitored in the application of conventional technologies for extending concrete’s lifespan under such conditions – such as how fine the concrete’s raw materials are, how long it takes to transport the fresh concrete, or the concrete’s compression during pumping. MasterSphere, however, is impacted by none of these factors. This not only makes application easier for our customers, it also substantially increases the concrete’s durability. Buildings are given an improved lifespan, especially in cooler climates.

Our new RELEST® Wind LEP ETU paint protects rotor blades even better – especially on the edges – from the enormous stress of rain, hail, snow, sand and ultraviolet rays. Before, an intensive process was required involving a special film. With RELEST® Wind LEP ETU, the paint can be applied directly following pretreatment. The substantial advantages here are especially apparent when touching up dings and scratches: Whereas in the past, a rotor blade’s film had to be entirely removed for repair work, damaged spots can now be treated individually and thus more efficiently.

The BMW i3, the first entirely electric production vehicle from the BMW Group, makes use of several of our innovative high-performance plastics at once. Their improved material properties make the car body sturdier, the roof construction stiffer and the seats more comfortable. The resilience of our Elastolit® polyurethane system was demonstrated in the Chinese province of Guangdong in July 2014: While more than 70,000 metal and concrete power pylons were severely damaged by Typhoon Rammasun, the pylons made with Elastolit®, which were installed as part of a pilot project, stood intact.

Agricultural Solutions: We work together with farmers to keep farmland arable for future generations and to accommodate society’s rising expectations. To do so, we constantly invest in our development pipeline in order to expand our portfolio both in and beyond conventional crop protection – such as in biological solutions. In 2014, we invested €511 million in research and development in the Crop Protection division, representing around 9% of sales for the segment.

Our innovation pipeline continued to increase in value in 2014. The pipeline comprises products launched in the period between 2010 and 2020. We foresee a peak sales potential of €2,300 million for these products, which represents an increase of €200 million compared with the previous year. The higher value is boosted by innovations in all application areas. Particular examples include a new, especially high-performance insecticide as well as the area of herbicide tolerance with the herbicide Engenia®, the next-generation dicamba formulation.

The Functional Crop Care portfolio has continued to show very promising development. For example, we will launch Serifel™, a biological fungicide from our Functional Crop Care research and development platform, on the market in 2015. Serifel™ fights fungal infections with a broad range of effects all the way up until harvest and is characterized by a variety of action mechanisms.

BASF Plant Science: We work with numerous biotechnology and seed companies, research institutes and universities worldwide to develop crops with higher yields and improved resistance to unfavorable environmental factors, such as drought. The drought-tolerant corn Genuity® DroughtGard®, the first product from our cooperation with Monsanto, allows for an average crop yield increase of more than 300 kilograms per hectare compared with competitors’ drought-tolerant corn varieties.

Oil & Gas: Our research and development activities focus on improving the discovery rate of oil and gas reservoirs, developing technologies for reservoirs with challenging development and production conditions, and increasing the recovery factor of reservoirs.

Our minimum facility platform in the L6-B field in the Dutch North Sea represents an important step in the more efficient production of small and medium-scale reservoirs. This mini-platform is 25% lighter than previous platforms and can be installed in merely nine months, substantially reducing purchasing and manufacturing costs. With this new generation of platforms, even the numerous smaller natural gas fields in the North Sea can be produced over a longer period of time in an economical manner.