



INDUSTRIAL RESEARCH IN GERMANY



AN INITIATIVE OF THE



Federal Ministry
of Education
and Research

Research in
Germany



Land of Ideas

OPPORTUNITIES IN INDUSTRIAL RESEARCH

“Made in Germany” – whether attached to cars or environmental technology, grand pianos or high tech, this label is a guarantee of quality, precision and innovation. These are the attributes that have made Germany’s economy so strong. Above all, this is because companies invest a great deal in improving their products: in hardly any other country does industry spend as much on research and development.

This brochure explains what makes German industrial research successful, and showcases the opportunities it offers talented researchers. Could you imagine joining a research team at a world-class company – either as a PhD or postdoc? Or how about starting a high-tech company yourself that draws on your own research? The following pages explain how.

Have fun discovering!



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Germany is home to some of the world's top research companies. They run their own research institutes, establish research associations and cooperate with universities and research institutions all over the world.

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Research-based companies are recruiting researchers by offering them well-paid jobs and special funding programmes. There are many opportunities if you wish to share in the success of German industrial research.

A BRIGHT FUTURE FOR START-UPS 22

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IMPRINT



USING AUGMENTED REALITY TECHNOLOGY TO WATCH VIDEOS

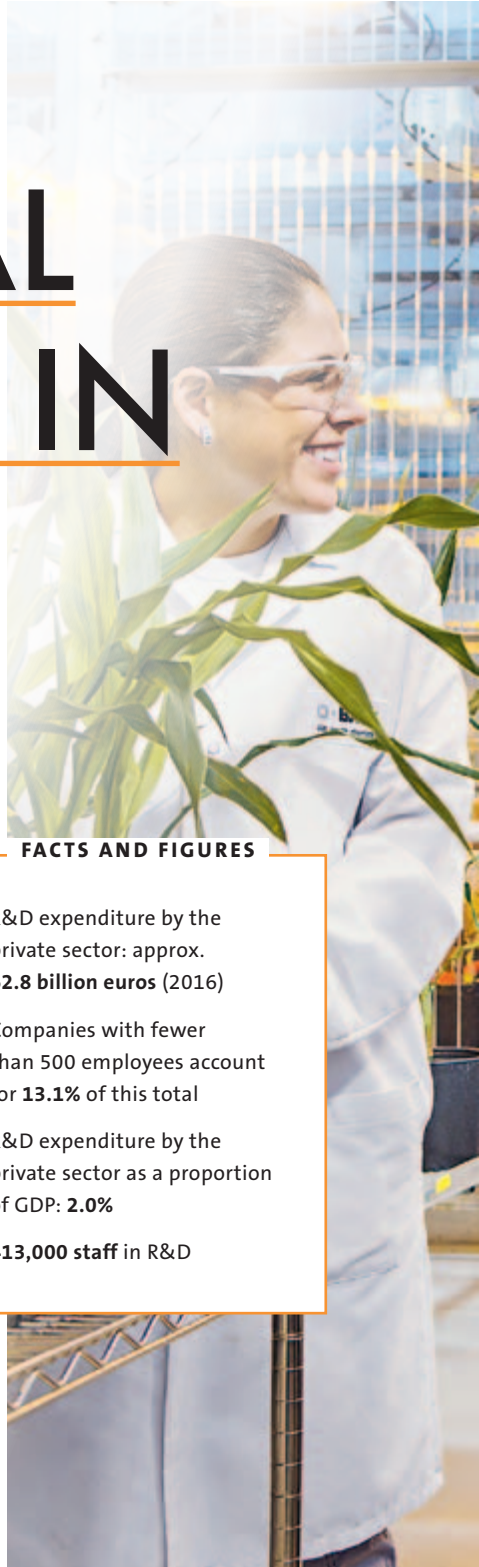
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INDUSTRIAL RESEARCH IN GERMANY

Inventive and innovative:
Germany is home to some of the world's top research companies. They run their own research institutes, establish research associations and cooperate with universities and research institutions all over the world. And they do so with striking success.

German companies such as Bosch, Siemens und BASF are among the world's most active patent applicants.



FACTS AND FIGURES

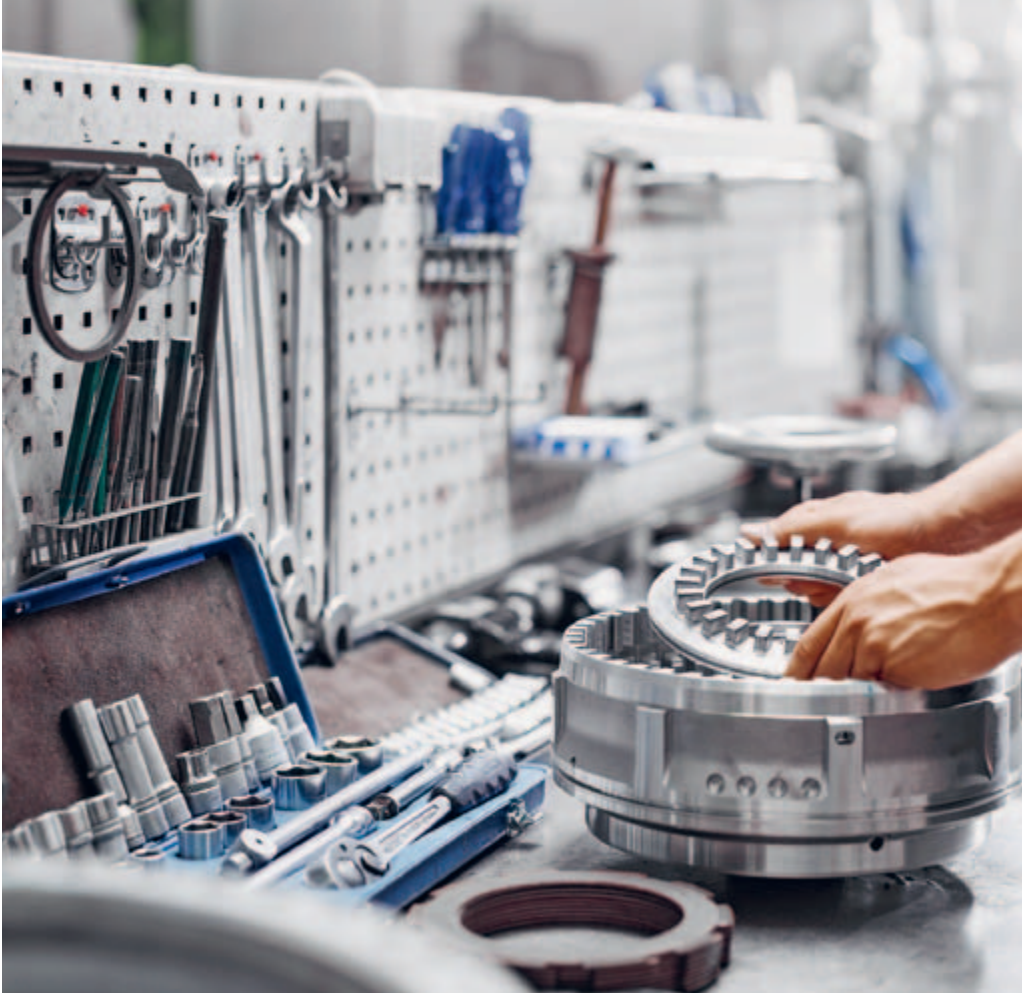
R&D expenditure by the private sector: approx. **62.8 billion euros (2016)**

Companies with fewer than 500 employees account for **13.1%** of this total

R&D expenditure by the private sector as a proportion of GDP: **2.0%**

413,000 staff in R&D





Finding solutions is one of the real strengths of German industry. Whether it is a question of developing self-driving cars or creating applications for artificial intelligence in medicine – German companies are among the world's **most innovative inventors**. Research and development (R&D) plays a key role in German industry, and major corporations such as Bosch, Siemens and BASF are among those firms that register the most international patents worldwide. Research-based companies in

Germany spend nearly 63 billion euros on R&D – meaning that Germany is home to some of the **world's most research-intensive companies**.

No company in the world invests as much in research as the German auto giant Volkswagen. Its research focuses on areas such as carbon-neutral engine and fuel strategies, assisted-driving systems, materials optimisation and urban mobility concepts for the future.



Volkswagen AG, schaeffler.de

No other company in the world spends as much on research as the German auto giant Volkswagen.

Germany is home to many innovative small and medium-sized enterprises that are world leaders in their segments, such as the automotive supplier ZF Friedrichshafen.

HIDDEN CHAMPIONS

It is not only the big household names that are researching for the future, however. A whole host of **hidden champions** in Germany are, too – like the technology firm ZF Friedrichshafen AG. An automotive supplier, it is one of the companies that files the most patents with the German Patent and Trade Mark Office. Though this is hardly surprising given that ZF Friedrichshafen spends more than six percent of its annual turnover on research and development. Family-owned Schaeffler is also

a hidden champion in its market segment, predominantly because of its research activities. This industrial supplier invested 846 million euros in future technologies and knowledge transfer in 2017. Among other things, the company develops low-friction bearings for wind turbines and paves the way for industrialised fuel cell technology.

COOPERATION

Schaeffler is also a good example of how enterprises in Germany **engage in research**





schaeffler.de, BASF SE, p. 11: Phil Lee/Michael Demora/Getty Images

Schaeffler is one of the world's largest family-owned companies with more than 7,500 employees working in research.

The German chemical giant BASF from Ludwigshafen is one of the world's largest R&D investors.

cooperation with universities and non-university research institutions: be it on a national level with Friedrich-Alexander-Universität Erlangen-Nürnberg and the Karlsruhe Institute of Technology (KIT) or internationally such as with Southwest Jiaotong University in Chengdu in China.

Germany's research policy fosters cooperation between industry and universities and research institutions – especially on a regional level. Numerous **funding programmes** like the Clusterplattform Deutschland, the research campuses and the Leading-Edge Cluster Competitions support joint research programmes or help with the establishment of cooperation models.

RESEARCH FUNDING

Like many thousands of other companies, ZF Friedrichshafen and Schaeffler belong to the industrial research associations in their sectors; the goal of such associations is to drive forward

the innovative development of products and services.

More than a hundred of these research associations have joined forces under the umbrella of the **German Federation of Industrial Research Associations (AiF)**. The AiF not only coordinates publicly-funded “Industrial Collective Research” that sees research projects initiated primarily by small and medium-sized (SME, see page 12). Together with its affiliates, it also supports SMEs with their individual research needs.

Germany's Federal Government finances the research funding for SMEs: each year, some 535 million euros in public funding is channelled via the AiF into industrial research and the transfer of research findings into commercial use. As such, it is the biggest source of research funding for the SME sector.



62.5

billion euros

was spent on research and
development worldwide by Germany's
20 top research companies in 2017.



INDUSTRIAL COLLECTIVE RESEARCH

Strength in numbers

Most of us have probably made a paper aeroplane at one time or another to see whether it would fly. Though paper has never really caught on as a building material in the aviation industry, this may now be set to change. Scientists at Papiertechnische Stiftung (PTS) in Heidenau and at TU Dresden have been working on improving the load-bearing capacity of paper so as to make it an attractive material for building aircraft. For this purpose, they have designed a new three-layer material comprising a “sandwich” of aramid paper and carbon fibres, which may prove suitable for aircraft construction. Such a lightweight structure would significantly reduce fuel consumption and material resources.

The paper aeroplane is just one of around 1,600 research projects that are supported and funded each year via the **German Federation of Industrial Research Associations (AiF)** within the framework of its **Industrial Collective Research (IGF)**. The IGF is unique in the world, with mainly small and medium-sized enterprises from all sectors of German industry collaborating there. Together with scientists, they identify which research is needed and should be pursued. More than 500 independent experts from the fields of science and business work there on a voluntary basis.

To this end, companies and business associations in the various sectors have established 100 non-profit research associations that bring together around 50,000 members. To implement the research projects, the research associations have their own institutes in some

The AiF is a research network for small and medium-sized enterprises in Germany. It funds research, transfer and innovation. Since its foundation, it has channelled around 11.5 billion euros in public funding into new developments and set some 230,000 research projects in motion.

WWW.AIF.DE

cases, and collaborate with universities and non-university research institutions.

The joint research projects are coordinated and organised by the AiF, with which the research associations of the companies have joined forces. The Federal Ministry for Economic Affairs and Energy finances this pre-competitive research with over 170 million euros per year.

And best of all, the results of the IGF projects are published and made available to all companies.

More information:
www.research-in-germany.org/aif



” Our mission is to boost the innovative capacity of SMEs



DR THOMAS KATHÖFER,
CEO of the AiF

What makes the AiF special?

The AiF's mission is to boost the innovative capacity of SMEs. Working with the Federal Ministry for Economic Affairs and Energy (BMWi), it does so by supporting their cooperation with research institutions through two research funding programmes: Industrial Collective Research and the Central Innovation Programme SME. This allows companies to keep their products competitive by drawing on current scientific knowledge.

How would you describe the AiF's significance in terms of research in Germany?

The AiF is the cooperation and transfer platform for German SMEs. More than 50,000 actively researching SMEs and 1,200 departments at research institutions (university chairs, institutes etc.) are currently members of the AiF's network.

How important is the next generation of scientists for industrial research in Germany?

Young scientists are vital when it comes to industrial research. Projects in Industrial Collective Research in particular play a key role here: young scientists are involved in every project – many of them later switch to small and medium-sized enterprises.



A CAREER IN INDUSTRY

How about a job in industry as a young researcher? Why not: German companies spend a lot of money on research and development, pursue international activities, enjoy worldwide success and have labs and R&D departments that could hardly be better equipped. Now research-based companies are recruiting young researchers by offering them well-paid jobs and special funding programmes.

Leading research-based companies like Siemens offer dedicated programmes and special funding for doctoral students.





FACTS AND FIGURES

236,000 researchers work in R&D in companies

5% of doctoral students are employed by a company

A further **5%** of doctoral students receive third-party funding from industry



Bosch; Hero Images/Getty Images; Comstock/Getty Images



Many German companies invite doctoral students to apply to work on their planned research topic.

Doing a PhD while gaining professional experience at the same time: Bosch recruits doctoral students by offering a special doctoral programme, an employment contract and intensive support.

Planning a PhD after your master's degree? If you would also like to gain some practical professional experience and find out what it is like to work in a company, there is one option that you may wish to consider. **Research-based companies are increasingly cooperating with universities** – not only on research projects but also when it comes to training doctoral students.

A DOCTORAL STUDENT IN INDUSTRY

One such researcher is Patricia Haremski. A young physicist, she is doing her PhD at the **Karlsruhe Institute of Technology (KIT)** while working at the industrial company Robert Bosch. For her this was the right choice: “Because of my degree course I was already familiar with scientific work at the university – but not with everyday life in industry, which I was keen to get to know.”

Although you can only take a PhD at a university, roughly one in 20 doctoral students also works at a company.

DOCTORAL PROGRAMMES

BASF and many other companies invite doctoral students to apply to work on their planned research topic. And, like Bosch, large research-based companies such as Volkswagen, Audi, Infineon, Porsche and Siemens use dedicated programmes and special funding to attract potential doctoral candidates.

Patricia is on a doctoral programme at Bosch. “The programme won me over immediately – particularly because of the large number of doctoral students who work at Bosch. So I knew I wouldn't end up on my own there.”



10,200

DOCTORAL STUDENTS

were employed in industry during the 2014/15 winter semester.

Source: Destatis



Globally-active research-based companies such as Boehringer Ingelheim offer young researchers the opportunity to acquire international experience and network worldwide.

WHAT'S IN IT FOR ME AS A PHD?

- You can finally work on **something practical**
- Normally you will **earn more** than at a university
- You can **gain professional experience** and find out what it is like to work in industry
- You can take advantage of the **company's infrastructure**
- You will acquire **additional qualifications** and soft skills
- You will have good (inter-national) **networking opportunities**
- Your **career prospects are better**, also if you return to your home country

Boehringer Ingelheim: Hero Images/Getty Images; private

CLOSE COOPERATION

A PhD is always supervised and assessed by a professor, however, as only universities can award a doctoral degree. Consequently, **doctoral students are supervised in close cooperation with the university.**

Where and how you will end up researching and working can differ considerably. Patricia Haremski studies the microstructure of fuel cells and tries to find ways to make them last longer and be more efficient. To this end, she spends a lot of time in the company's lab, as well as in the research department at KIT.

Some doctoral students who are funded or employed by companies have a workplace only at the university. Others, especially those in the engineering sciences, work mainly in the research labs of their company.

PROFESSIONAL AND SCIENTIFIC EXPERIENCE

For Patricia Haremski, doing a PhD while working for a research-based company is the ideal choice. Looking back after a year at Bosch, she feels extremely positive: "An industry-based PhD was the perfect fit for me. I find out what everyday life in a company is like, while at the same time engaging intensively with a topic on a scientific level."



“Thanks to the industrial experience I gained as a mathematician in engine development, I can add colour and variety to my teaching at the FH Aachen.”

PROFESSOR KARIN MELCHER, teaches mathematics at FH Aachen University of Applied Sciences. She was previously an engineer at BMW, where she worked on developing petrol engines.

Industrial experience is an important requirement in the engineering sciences.

A POSTDOC JOB IN INDUSTRY

How about a postdoc job in industry? For many that's an attractive option: it is all about finding solutions that really work, and then putting them into practice. You will be working in a team and establishing a new network. What is more, **your career prospects will also be good** – even if you decide to return home at a later date.

EXCELLENT EQUIPMENT

One aspect that makes research in industry so attractive is the excellent equipment. For Christjan Knudsen, Senior Vice President and Chief Human Resources Officer at Boehringer Ingelheim, it is

quite clear: “Our postdocs benefit from the well-funded research environment we provide, as it is equipped with all the necessary resources. This gives them the chance to gain deep insights in the field of discovery research.”

INTERNATIONAL CONTACTS

In globally active research-based companies like Boehringer, you will have the opportunity to acquire international experience and make contacts around the world. This may well be of interest to **international postdocs** in particular, as the company may have a research centre or contacts in their home country.



BASF is one of the world's most research-intensive companies. The chemical giant employs around 10,000 people in research and development at some 70 locations around the world.

The young researchers are supported by special programmes: “Our postdocs are part of a global postdoc community and can take advantage of our extensive scientific partnerships”, explains Knudsen.

CAREER OPTIONS

Christjan Knudsen also sees no reason why working in industry and pursuing a subsequent academic career should be mutually exclusive: “We give our postdocs the best possible preparation for launching their career, either at a university or in the pharma industry.”

As longstanding HR director Knudsen adds, the necessary springboard for postdocs is in place: “Our postdocs are given the optimal conditions – also when it comes to publishing their own research findings. What is more, they can attend expert lectures and scientific conferences.”

WHAT'S IN IT FOR ME AS A POSTDOC?

You will gain **professional experience in industry**

You can acquire **additional qualifications**

Your **career prospects** improve, even if you return home

You achieve the qualifications necessary for a **professorship at a university of applied sciences**

You pave the way for a **professorship in engineering**

You will have (international) **networking opportunities**

There is nothing to prevent them returning to university, in other words. In the engineering sciences, industrial experience has traditionally been an important requirement when applying for a professorship. And universities of applied sciences also expect their **future professors to have relevant professional experience** outside the academic world.

TEAM PLAYERS NEEDED

So how does one become a postdoc in a research-based company? Is a good PhD enough? Christjan Knudsen explains: “When recruiting postdocs, we don't look only at conventional research qualities such as inquisitiveness and persistence, but also at their ability to think and behave like entrepreneurs. To successfully ready our products for the market, we need genuine team players who stand out on account of their innovative ideas and persuasive communicative skills.”



VIDEO – HOW DOES IT WORK? SEE PAGE 5



Dr Ghislan Mouil Sil talks about writing his doctoral thesis at Robert Bosch.



BASF SE, Westend63/Getty Images

A postdoc job in industry is an attractive option for many young researchers.

A BRIGHT FUTURE FOR START-UPS

The quality of the German start-up scene has been improving in recent years: today's entrepreneurs are more idea-driven, growth-oriented and innovative. And there is good news if you are thinking about starting your own business: the environment for start-ups is also a lot better now.

Good conditions for entrepreneurs: Germany has better public funding for start-ups than any other country.

FACTS AND FIGURES

557,000 entrepreneurs, 14% with innovative and 26% with digital business ideas

Around **15%** of start-ups are scientific spin-offs

Roughly **10%** of business founders come from abroad







Westerhof/Cetty Images

Germany's start-up scene is in flux: a new generation of business founders is emerging who have one thing in common – they pursue research and development as a matter of course, use digital technologies or launch businesses that they want to see expand in the future. The young start-ups develop technologies for medical product innovations, new forms of mobility or applied artificial intelligence.

One such young and innovative company is the multi-award-winning start-up ArtiMinds Robotics. ArtiMinds has developed software that allows industrial robots to be programmed quickly and intuitively: the robot copies human movements and learns how to react flexibly to problems. It can then reliably solve even complex tasks.

An idea that is as brilliant as it is convincing, this has been a real success story. A 2013 spin-off from the Karlsruhe Institute of Technology (KIT) has evolved to become a technology company employing over 60 people and supplying the world market from its Karlsruhe base.

SCIENTIFIC SPIN-OFFS

All three of the young founders of ArtiMinds were research associates at KIT. Known as the “research university in the Helmholtz Association”, it is ideally positioned to help high-tech spin-offs get off the ground.

In 2017 alone, **this institution of top research and scientific excellence registered 124 inventions and 55 patents**, and enabled 28 spin-offs.



Wladimir Bulgar/Science Photo Library/Getty Images

Many young entrepreneurs pursue innovations in medicine and mobility or projects in artificial intelligence.

Successful German companies also generate spin-offs from innovative projects or create international start-ups.

Like KIT, other non-university research institutions such as Fraunhofer and the Max Planck Society, not to mention universities and higher education institutions, are also involved in **the transfer of scientific projects to business product development.**

BUSINESS SPIN-OFFS

Existing companies also generate spin-offs from innovative projects or create internal start-ups. The technology giant Bosch, for instance, funds young businesses all over the world with a start-up platform and invests millions in internal and external start-ups. Or Daimler, which specifically targets innovative start-ups: together with the University of Stuttgart, Porsche, BASF, ZF and other partners, the company explores

HOW TO BECOME AN ENTREPRENEUR

What you should think about:

What do I contribute?

Strengths, experience, money, contacts

Do I have a viable business idea? Who will be my customers? What is the market like? How big is the risk?

What support is available?

Information, funding, networks, contacts

What you should do next:

Now it's time to begin planning! Write a business plan, clarify insurance issues, plan a retirement pension

Now it's time to think about money! Calculate your capital requirements, talk to your bank, apply for funding, apply for a tax number, clarify your status with your local tax office

Now it's time to get started! Register your business, contact your local chamber of commerce, prepare your marketing strategy and activate your networks

Keep your nerve! Be realistic. Not everything will run smoothly at first. Get the help and advice you need, and never lose your passion

Information, checklists and practical help can be found at www.existenzgruender.de



Universities and non-university research institutions support the transfer of research into product development.



Wladimir Bulgur/Science Photo Library/Getty Images; Westend63/Getty Images; Praksiti Khuanisuwani/Getty Images

opportunities for cooperating with hard-tech start-ups through its “Startup Autobahn” programme. Other leading car manufacturers like Audi and Volkswagen have also stepped up their investments in start-ups.

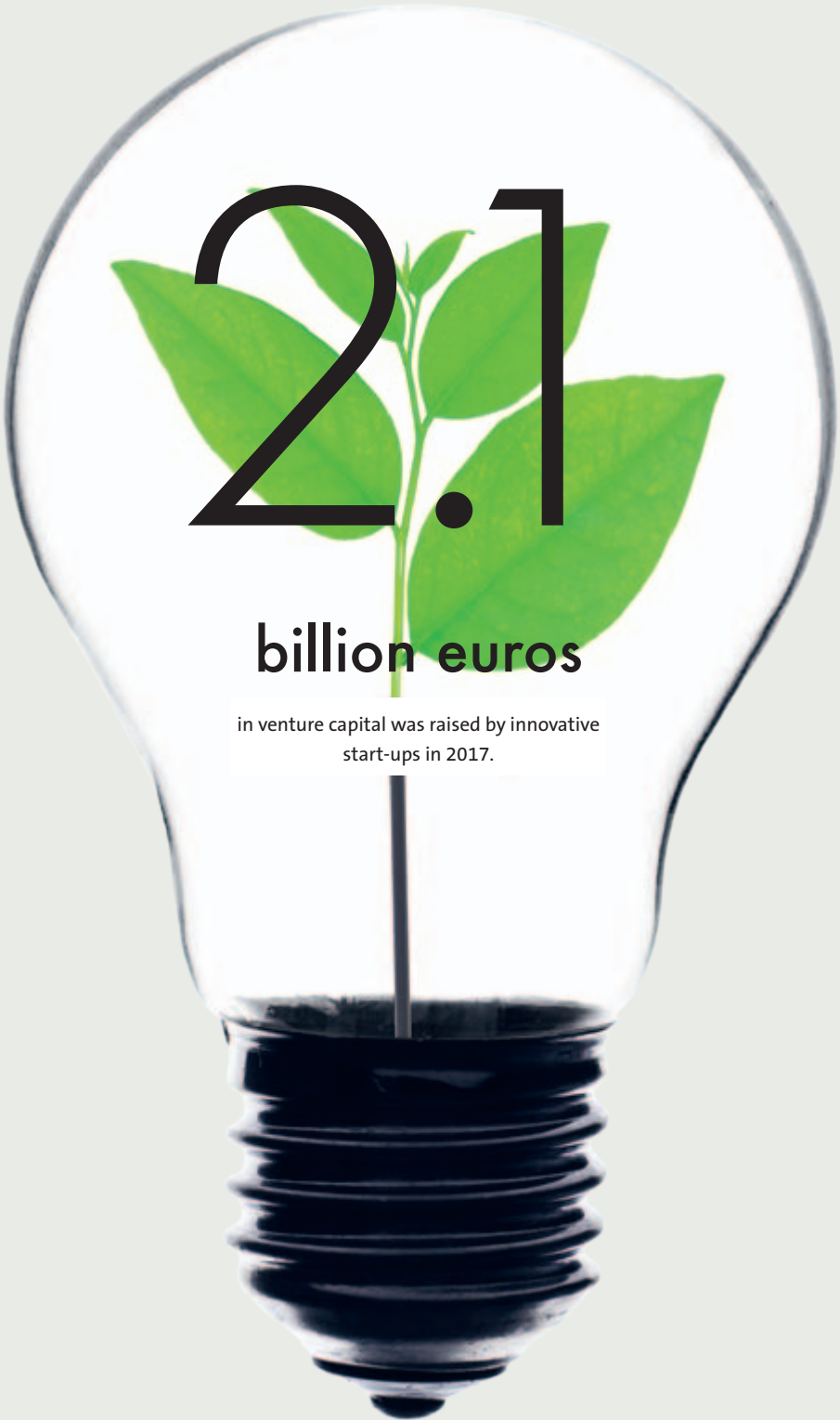
FUNDING FOR START-UPS

Of course, not all start-ups receive initial funding from universities or companies. All the same, they can expect some support: besides the numerous awards and start-up prizes, substantial financial support is also available from public-sector funds, as is long-term coaching. There is indeed **very good public support for start-ups**. As experts attest, “in an international comparison, there is no country with a significantly higher performance than Germany”. This is the conclusion drawn in the annual Start-up Monitor published by the KfW Group.

For example the **High-Tech Gründerfonds** (HTGF), Germany’s biggest investor when it

comes to early-phase financing of innovative and technology-oriented companies. It provides support right from the start. **Funding comes mainly from the Federal Government**, followed by KfW Group. Private investors from small, medium-sized and large companies also contribute to the fund. The HTGF helps not only by providing early-stage funding but also actively supports you in getting your new business off the ground.

If you are launching a scientific spin-off, the publicly-funded EXIST programme may be of interest. The programme, which also helped ArtiMinds to get started, supports researchers and students in preparing and implementing their research-based start-ups, accompanying them from the business plan stage right up to the actual launch. This is done by providing grants or paying for personnel and equipment, by funding development work and covering start-up costs, and by offering coaching and seminars.



2.1

billion euros

in venture capital was raised by innovative
start-ups in 2017.



VIDEO – HOW DOES IT WORK? SEE PAGE 5



In the video, Sven Schmidt-Rohr explains how a good idea was transformed into a successful company.

“As compared with other leading nations with similarly large domestic markets, entrepreneurs in Germany benefit from a strong infrastructure, a reliable and efficient legal system, well-educated, creative and motivated university graduates, and solvent business customers.”

DR SVEN SCHMIDT-ROHR,
CEO ArtiMinds Robotics



Roughly 15 percent of start-ups in Germany are scientific spin-offs.

Research-based companies are also stepping up their cooperation with the new start-ups.

Another option is to engage a business angel: these private investors contribute not only their capital to a young company – they also make their expertise, market knowledge and networks available. Normally they are involved only in the initial phase of a company and tend to invest for just a limited period. **To find your angel, get in touch with a business angel association**, many of which also belong to the Business Angels Netzwerk Deutschland. Or attend a matching event or one of the numerous other events aimed at entrepreneurs.

VENTURE CAPITAL

Generally speaking, the environment for start-ups and spin-offs has improved in recent years, and there is also progress when it comes to investment: besides the considerable public-sector financing that is available, private investors are increasingly providing venture capital. This benefits innovative

financial services providers (e.g. for blockchains and cryptocurrencies) in particular, but also auto-tech start-ups, bio-tech companies and businesses working in augmented and virtual reality.

SPRINGBOARD INNOVATION

These are also the fields of research that interest **Germany's new Agency for the Promotion of Springboard Innovation**: the idea is to support breakthroughs in artificial intelligence applications, new forms of mobility or medical technology innovations.

In an initial phase until 2022, the agency, which is to begin its work in 2019, will have more than 150 million euros at its disposal. Presumably another billion euros will then be made available for the first ten years. The money is intended to help researchers and inventors turn their groundbreaking ideas into reality.



ABOUT THE INITIATIVE “RESEARCH IN GERMANY – LAND OF IDEAS”

The Federal Ministry of Education and Research (BMBF) launched the initiative to “Promote Innovation and Research in Germany” in 2006. Since then various measures and events have been organised under the brand “Research in Germany – Land of Ideas” to present German innovation and research worldwide. The initiative also seeks to build strategic partnerships with institutions outside Germany.

The BMBF has also established the Research Marketing Alliance, a joint dialogue initiative for research, education, business and politics. This alliance aims to further strengthen connectivity between the actors of the German research,

education and innovation system and to fully exploit the potential for individual and joint communication activities under the “Research in Germany” brand umbrella.

This and many other “Research in Germany” publications are available at www.research-in-germany.org/downloads

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Note The DAAD places special emphasis on using language that treats women and men equally. The grammatical male form is occasionally used alone in this publication purely as a means of improving legibility. Naturally, these terms are meant in a gender-neutral way.

Cover photo Westend61/Getty Images

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