



Federal Ministry
of Education
and Research

Internationalisation of Education, Science and Research

Strategy of the Federal Government



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Foreword

Education, science and research stand for openness and freedom of thought. A free spirit knows no borders, it transcends them. It seeks stimulation in all possible areas and countries.

It is this transnational way of thinking that is at the heart of the Federal Government's Strategy for the Internationalisation of Education, Science and Research. And this is crucial for our future viability in the age of globalisation. Challenges such as climate change, sustainable energy supply and other central issues do not stop at national borders. No country can answer these challenges by itself. We need international collaboration – in the area of science and research in particular.

Economic and scientific spaces are growing ever closer together, with digitalisation accelerating this development to breakneck speed. New global centres of innovation are arising. We are on the path to a global community of knowledge where the potential for making great advances in our knowledge is enormous.

The Federal Government's Strategy for the Internationalisation of Education, Science and Research aims to steer the path to that global community of knowledge. We are laying the foundations for closer, more connected collaboration. The European Research Area is becoming more and more important for structuring this collaboration. More synergies, more coherence, building more bridges – these are our key objectives. In so doing, we will safeguard the competitiveness of our country while helping to find sustainable solutions to global problems.







1 Key points in brief

Germany's education, science and innovation system must be organised to operate internationally if it is to persist in the face of global competition while living up to its responsibility to help solve the global challenges. The Federal Government is creating the right conditions for this through its Internationalisation Strategy. Against a background of increasing digitalisation, growing complexity and the need for sustainability, we must update our methods of international collaboration. Accordingly, the Federal Government is assuming responsibility for the safeguarding of quality of life, health and prosperity in the age of globalisation, and is drawing upon the potential of international cooperation in education, science and research to do so.

The guiding principle of this strategy is "International cooperation: networked and innovative". In concrete terms, this means that international cooperation is effective, efficient and focused on achieving strategic

objectives. It employs synergies between the various activities of the participating stakeholders from science, industry and politics to achieve the greatest possible impact.

Objectives

Strengthening excellence through global cooperation

Scientific excellence thrives on interchange and competition among the world's best. The Federal Government will thus take steps to further consolidate Germany's position as an internationally attractive location for study and research, and will at the same time continue to remove barriers to the international mobility of German scientists. Above all, however, Europe remains an important point of reference and the Federal Government will continue to actively promote the deepening of the European Research Area (ERA).

Developing Germany's strength in innovation on the international stage

As a base for high-tech activities, it is important that Germany be fully integrated into global knowledge flows and value chains. Successful international networking brings immediate competitive advantage. The Federal Government will continue to promote this networking and will, in particular, support small and medium-sized enterprises (SMEs) in international cooperation on innovation. It will at the same time also work to best shape the essential framework conditions for cooperation, for example concerning the handling of intellectual property.

Internationalising vocational training and qualification

Germany has a vital interest in international cooperation in vocational training. Adequately trained professionals contribute to sustainable development in partner countries and are, at the same time, an important prerequisite for German companies' engagement in their target countries. The Federal Government will take steps to expand cooperation in vocational training with industrialised and emerging countries, to increase the mobility of trainees and to further simplify the recognition of qualifications that foreign professionals have obtained abroad. The fight against youth unemployment in Europe remains an important objective.

Working with emerging and developing countries to shape the global knowledge-based society

As aspiring science nations, many emerging and developing countries are becoming increasingly relevant as partners in the joint shaping of a global knowledge-based society. The Federal Government will expand existing cooperation with emerging and developing countries and create new partnerships. In this context, digitalisation offers important opportunities for facilitating greater access to knowledge. Together with our partners, we want to spread good practices in scientific endeavour and contribute to the implementation of uniform guidelines and standards worldwide.

Overcoming global challenges together

Global challenges such as climate change, health and food security do not stop at national borders. They can be successfully addressed only by transnational efforts at the European and international level. Education and research create the knowledge needed for evidence-based policies. The Federal Government will step up its efforts to ensure that barriers to effective research into global challenges are surmounted and that the relevant stakeholders at the European and international level can interact more closely with each other.

The Federal Government will also focus on new cross-cutting measures in research and academic relations policy and on international networking. The training of future elites in partner countries creates durable relationships and promotes interest in scientific endeavour in Germany. Alumni in many different countries play a part in determining the image of Germany in the world. Moreover, scientific exchange influences the pre-political sphere and serves to keep communication channels open even during tense political situations. At the same time, research and academic relations policy helps create scientific and academic perspectives in times of crisis and in conflict regions.





2 Achievements, trends and challenges



“To strengthen Germany’s role in the global knowledge-based society”: this was the objective announced by the Federal Government when it adopted its Strategy for the Internationalisation of Science and Research in 2008. With this strategy, the Federal Government defined for the first time a framework for a coherent approach to international cooperation in the fields of science and research and, in so doing, positioned Germany in the international vanguard. Research and intermediary organisations – the German Research Foundation (DFG), Fraunhofer Society (FhG), Helmholtz Association (HGF), Leibniz Association (WGL), Max Planck Society (MPG), German Academic Exchange Service (DAAD) and the Alexander von Humboldt Foundation (AvH) – as well as numerous German institutions of higher education have developed their own strategies based on that of the Federal Government. In addition, it is within the scope of duties of the departmental research institutions to work with international organisations and institutions.

Since 2008, new trends and challenges have arisen or intensified that have had significant effects on international collaboration in education, science and research. These include the increasing globalisation and digitalisation of education, science and research, but also the evolution of the ERA and the emergence of new global centres of innovation.

It is against this background that the Internationalisation Strategy of 2008 is being further developed. The Federal Government wants to both reflect the new trends and define necessary actions for the future, and in this way is providing a framework for the actions at

the international level of the various stakeholders in the German science and innovation system.

The measures set out in the strategy fall under the responsibility of the respective governmental departments. Funding will be agreed upon with other participating departments – subject to the availability of funds – within the framework of current budgetary and financial planning principles (including staff allocation).





2.1 Achievements

Germany has achieved a great deal since 2008. A strong national research system is essential to the efficient integration of Germany's strategy into the global science and innovation system. Germany is well placed in this regard, with both German companies and public authorities continuing to invest in education and research in recent years despite the economic and financial crisis. The share of Germany's gross domestic product (GDP) invested in research and development (R&D) grew from 2.4% in 2005 to 2.9% in 2014, putting Germany – along with Finland, Sweden, Denmark and Austria – in the leading group in Europe. Internationally, only Israel, South Korea and Japan spend a larger share of GDP on R&D.

Public sector expenditure on education increased by one-third to around EUR 123.7bn between 2008 and 2015; the Federal authorities increased their expenditure on education by 80% to EUR 9.1bn over the same period.

During the current legislative period (2013-2017), the Federal authorities are making available an additional EUR 9bn for education and research, of which EUR 3bn is for research. This investment also allows Germany to maintain its globally competitive position among the leading nations.

Total public and private expenditure in Germany on education, science and research rose to EUR 257.4bn in 2013 and is estimated to have reached EUR 265.5bn

based on preliminary calculations for 2014. This means that 9.1% of GDP was spent on education, science and research.

Integration into global knowledge flows is becoming ever more important for science and research, which is why the number of grants made by the Federal Ministry of Education and Research (BMBF) for projects involving collaboration with international partners more than doubled between 2009 and 2015, from around 1,500 to some 3,400. Together with institutional contributions towards international R&D infrastructure and programmes, the BMBF has itself increased funding for international cooperation from an annual figure of some EUR 567m in 2009 to approximately EUR 802m in 2015.

Figure 1: Gross domestic expenditure on research and development as proportion of gross domestic product (GDP): Germany and OECD average, 2005–2014



Sources: BMBF, Bundesbericht Forschung und Innovation 2016 (Federal Report on Research and Innovation 2016), supplement I (data on Germany); OECD, Main Science and Technology Indicators 2016 (data on OECD average)

Over the last few years, the Federal Government and individual ministries have outlined the necessary strategic framework for their activities in the areas of education, science and research. It includes:

- Strategy of the Federal Government on the European Research Area (ERA) (2014)
- One-stop International Cooperation in Vocational Training (Federal Government, 2013)
- Federal Government Policy Guidelines for Africa (2014)
- International Cooperation Action Plan (BMBF, 2014)
- The Africa Strategy (2014-2018) (BMBF, 2014)

- The China Strategy (2015-2020) (BMBF, 2015)
- G7 Vision for Global Health: A Contribution to the Improvement of International Health (BMG, 2015)
- Education strategy: Creating equitable opportunities for quality education (BMZ, 2015)

These strategic decisions were supplemented by joint resolutions of the Federal and *Land* authorities, in particular those for the higher education sector in the “Strategy of the Federal and *Land* Ministers of Science for the Internationalisation of the Higher Education Institutions in Germany” of 2013.

The state of progress in individual areas of activity since 2008

Excellence through international collaboration

International exchange ensures scientific excellence. This is why data on the international mobility of scientists, on international publications and on European integration forms a good basis for analysing Germany's position in the global knowledge-based society.

International student mobility has increased significantly across the globe. In 2013, over 4m students worldwide studied in a foreign country – in 2000, that figure was just 1.6m. Over half of all international students come from Asia. China has the largest number of its citizens enrolled as students abroad, followed by India and Germany. In 2013, 134,500 German students were enrolled at foreign institutions of higher education. Since 2008, the number of Germans studying abroad has risen by some 27%. Almost 60% of Germans enrolled abroad are studying in the four most popular destinations: Austria, the Netherlands, Great Britain and Switzerland.

Worldwide, Europe is the preferred destination region for international students: 43% of international students are enrolled in Europe. Around 339,000 foreign students were enrolled in German institutions of higher education in the 2015-16 academic year, making up around 12% of all students studying in Germany. This figure is based on the total number of foreign students, irrespective of whether they attained the necessary higher education entrance qualifications in Germany or elsewhere.

Around 236,000 foreign students who attained their entrance qualifications abroad completed a course of study in Germany in 2015. This makes Germany – despite the language barrier – the fifth most popular destination country after the USA, Great Britain, Australia and France. The three main countries of origin are China, Russia and Austria. DAAD supports a large number of international students, around 50,000 in 2014 alone.

Figure 2: Number of international students who obtained higher education entrance qualifications abroad, in the five most popular host countries worldwide (2013)



Source: DAAD, Wissenschaft weltoffen (Science open to the world) 2016

Foreign students already accounted for 10.4% of graduates from German universities and 7.6% of graduates from universities of applied sciences in the 2014 examination year. Over one-third of German students in the higher semesters of their higher education had spent at least some time studying abroad. Germany has already achieved the European mobility target that 20% of all graduates will have completed a course of study or a training/work placement abroad by 2020.

The Federal Government expects that support for studies and courses abroad under the German Federal Training Assistance Act (“Bundesausbildungsförderungsgesetz” – BAföG) will further contribute to increasing the mobility of students. The trend towards international mobility is also continuing amongst scientists, with around 60% of German researchers

spending at least three months abroad in the last ten years.

Compared to other European countries, German scientists are more mobile than their colleagues in either France or Great Britain (each just below 50%). However, studies show that only some 60% of German researchers who spend time abroad return to Germany. Not least with an eye to this figure, the challenge remains of retaining more high-calibre scientists in Germany – and also bringing them back to Germany from abroad – using funding from the European Research Council (ERC).

Figure 3: Destination of visiting German scientists by region (2014)

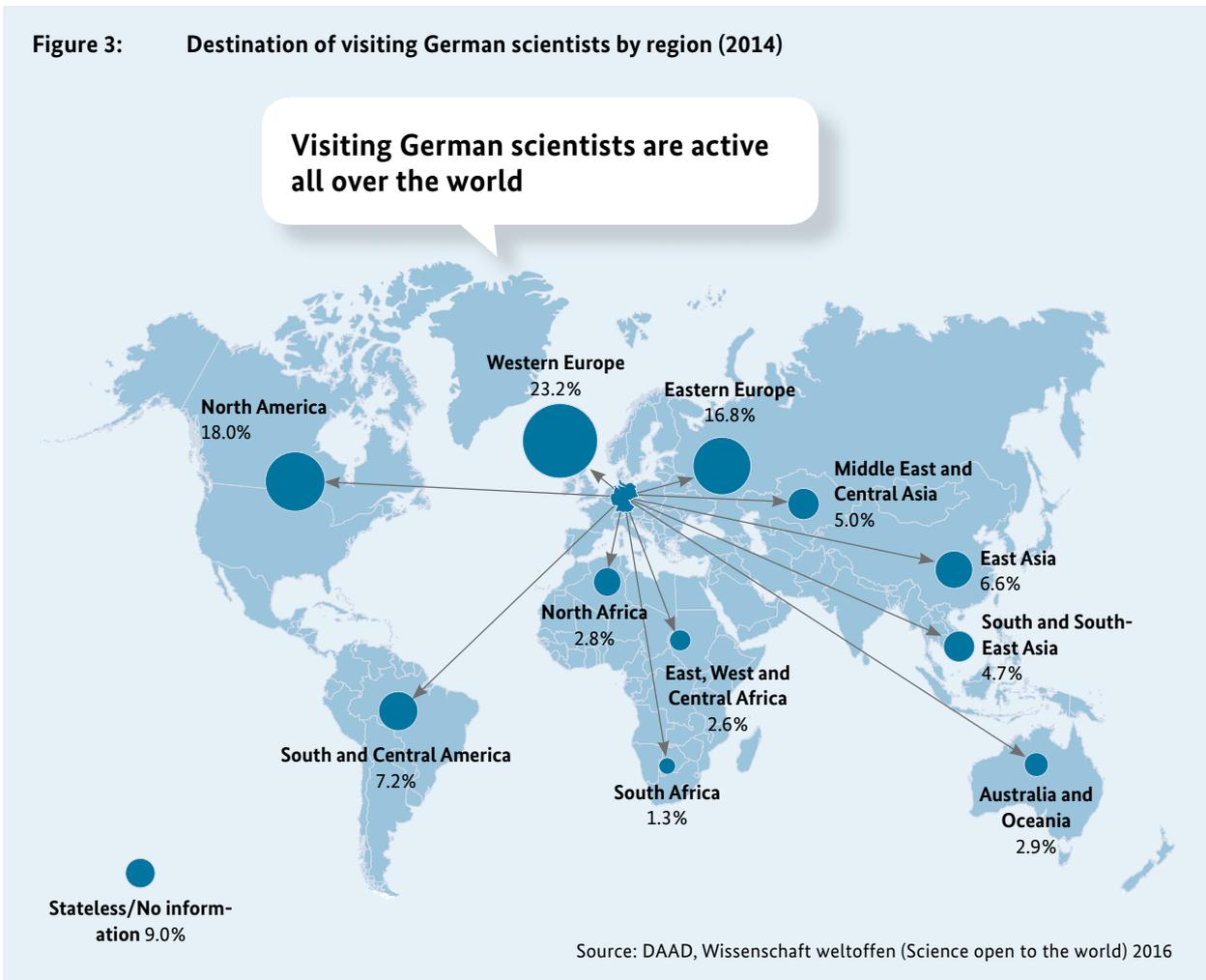
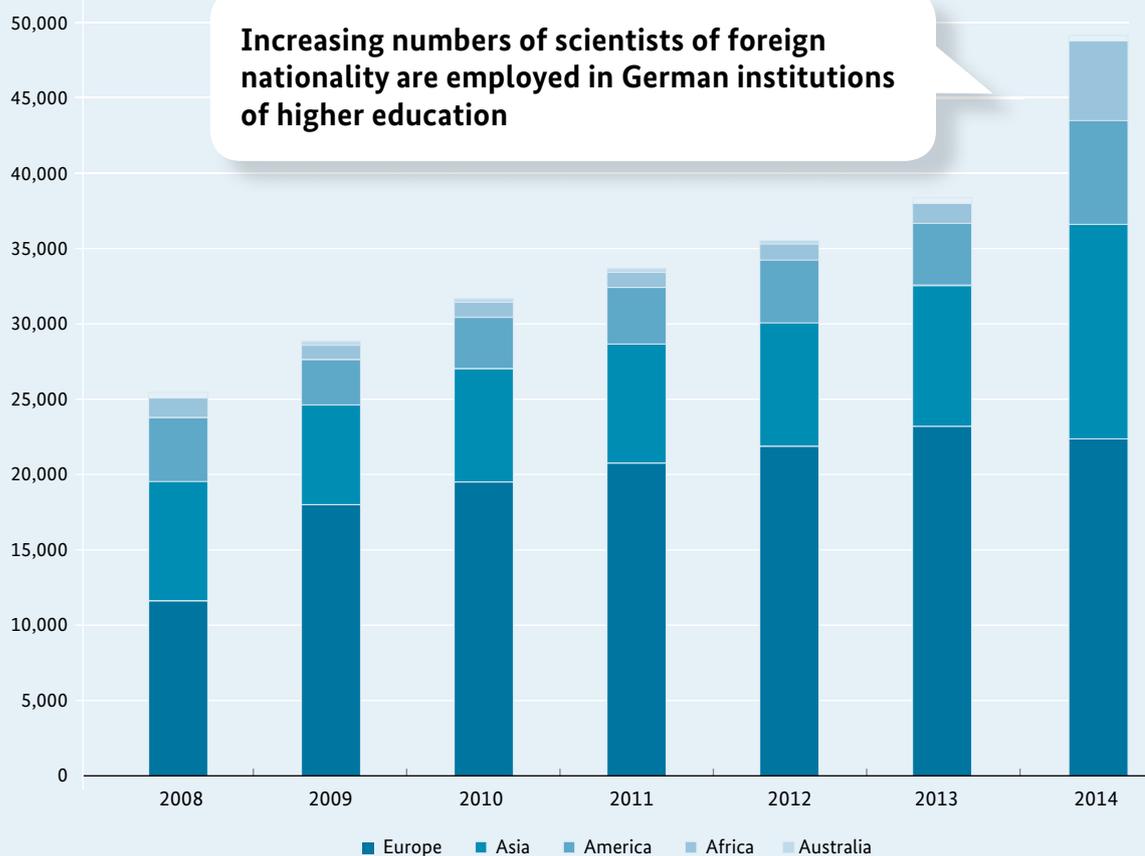


Figure 4: Scientists of foreign nationality in German institutions of higher education (2008–2014)

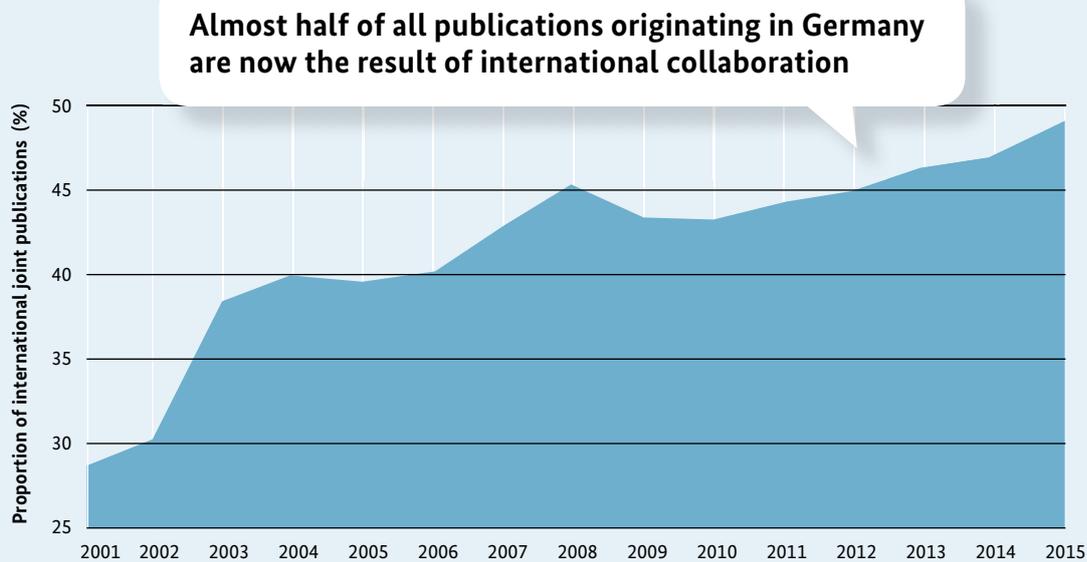
Source: DAAD, Wissenschaft weltweit (Science open to the world) 2016

The faculty at German institutions of higher education are also becoming increasingly international, with the numbers of foreign staff rising from around 26,000 in 2008 to roughly 49,000, or about 11% of total faculty, in 2014.

The Federal Government further opened up the German labour market for graduates with the introduction of the EU Blue Card in 2012. Between August 2012 and December 2015, a total of 37,606 Blue Cards were granted – almost 90% of all the Blue Cards issued in the EU and confirming that highly qualified migrants find it easier to live and work in Germany.

Just under half of all scientific publications originating in Germany are already the result of international collaboration. The total number of publications and their scientific influence (measured by the number of citations and their share of the most frequently cited articles) has risen continuously over the last few years. In contrast, the 2.4% increase in the absolute number of publications between 2002 and 2012 was below the world average of around 5%, due mainly to output from China.

Figure 5: Share of international joint publications in total German output



Source: Scimago (retrieved November 2016)

Overall, the available data and analyses indicate that Germany is well integrated into the global scientific landscape. Whether judged by the mobility of scientists or by the output of publications, Germany is one of the leading scientific nations in all fields. Current analyses show a link between the mobility of researchers and their scientific productivity. Publications by mobile researchers are on average of better quality than those of non-mobile colleagues.

It has also been proven that German researchers living abroad collaborate at an above average rate with German R&D institutions. Although the outflow of top scientists in particular initially causes a loss of research capability in Germany, networking effects and a tighter integration into the international flow of knowledge can in fact benefit the national research effort, at least indirectly. In addition, strong scientific networks have a positive effect on the political relations between states in advance of diplomacy.

Intra-European collaboration plays a central role in both the mobility of German students and researchers and the publication of scientific articles. Accordingly, some 90% of German researchers are currently active

in research and intermediary organisations that make a significant contribution to the ERA.

The Federal Government attaches high priority to further deepening of the ERA, and German stakeholders are involved in a large number of European initiatives. For example, many national research institutions have organised themselves to perform research at an EU level into rare diseases. Those institutions now coordinate over 50% of the funding in this field. The situation is similar in the metrology field (European Metrology Programme for Innovation and Research – EMPIR).

The integration of German research into the European scientific landscape can also be seen in the returns from European funding programmes for research and innovation. Between 2007 and 2013, German institutions and companies acquired over EUR 7bn from the 7th EU Framework Programme for Research (FP7). This made Germany the most successful Member State in absolute terms. Under FP7, German researchers worked with partners from 159 of the 176 participating countries – a total of over 18,000 participants in some 8,000 projects.



This high level of involvement is continuing under the “Horizon 2020” EU Framework Programme for R&I (2014-2020: total budget: around EUR 75bn at current prices). Germany has taken the lead in the opening phase of Horizon 2020 as measured by the number of project participations and the volume of grants (EUR 3.03bn as of October 2016). The share of SMEs amongst German participants stands at 19%, with German SMEs receiving 11.5% of all the grants made to German participants. This does however leave Germany – along with France and the United Kingdom – below the EU average for SME participation, which stands at 15.6%.

Germany is also an active participant in the European Higher Education Area – for example, in common instruments for quality assurance and transparency, the implementation of the European Credit Transfer and Accumulation System (ECTS), the European Quality Assurance Register (EQAR) and the further development of the “Diploma Supplement” for graduates. With 48 participating states, the European Higher Education Area extends beyond the boundaries of the EU.

Tapping international potential for innovation

The continuing strength of innovation in Germany guarantees international success as a location for innovation and industry, and it has secured a leading position for Germany among EU countries that has lasted for many years. The “European Innovation Scoreboard” index published annually by the European Commission in 2016 once again places Germany in the “Innovation leaders” group, along with Sweden, Denmark, Finland and the Netherlands.

Germany continues to be attractive to foreign companies as a base for innovation. Since 2008, expenditure by foreign companies in Germany on R&D has exceeded expenditure by German companies abroad. Thus, in 2011, foreign companies invested EUR 16.2bn in R&D in Germany, while in the same year German companies abroad invested EUR 14.8bn. At the same time, however, German companies increased their R&D investment abroad significantly faster than within Germany. Thus the share of R&D expenditure abroad in total R&D expenditure rose from 27% in 2007 to around 30% in 2013.

Regardless of the location of R&D investments, a significant increase in international R&D cooperation can be observed. There are many reasons for this, the most important of which are the growing interrelationships of companies across borders, the enormous increase in complexity of development tasks, and the burgeoning costs of development. It is very often the case that individual companies or establishments possess neither the expertise nor the resources to undertake research projects on their own. Transnational cooperation in R&D also makes it possible to better cater to local market and customer requirements, mitigate development risks, or smooth peaks in demand.



An essential prerequisite for the strengthening of cooperation in innovation is the fair use of the associated intellectual property rights. The BMBF published a guideline back in 2009 for the protection of intellectual property in international collaborative projects.

The competitiveness of any location as a base for innovation is increasingly determined by close integration into knowledge networks at both the European and wider international levels. It was therefore logical for the Federal Government to identify networking at European and international level as a key objective within the framework of the new High-Tech Strategy in 2014.

The translation of research results into practical applications is dependent in particular on the creation of favourable conditions at the international level. The Federal Government's departmental research institutes also contribute to the success of innovation processes and to overcoming global societal challenges through their scientific commitment to the development and international harmonisation of methods, standards, norms and regulations.

The constant rise of digitalisation in industry, science and society offers far-reaching opportunities including for international collaboration in education and research. For this reason, 'European and international collaboration' and 'education, science, research, culture and media' are two of the seven key areas for action in the Federal Government's Digital Agenda.

Vocational training

Education is the key to a fulfilled life, social advancement and participation in society. The level of education of the population living and working in a country determines its capacity for innovation and thus its competitiveness and prosperity. High quality and efficient general and vocational education

are the foundation of prosperity and employability. Excellent training and support for the next generation is important to the future of Germany as a location for business and innovation, and for international collaboration.

With regard to the international dimension, the Federal Government has focused in the past few years on the expansion of international collaboration in vocational training, on covering the German economy's requirements for professionals – both within Germany and abroad – and on increasing international mobility.

Germany's education and training system has shown itself to be robust and successful in the face of the financial and economic crisis. This is shown in particular by the generally smooth transition into working life and the resulting low level of youth unemployment, something not least due to the attractiveness of the dual vocational education and training system for young people and companies. This system allows companies to train their own future labour force in a way that meets their needs while, in most cases, offering the young person a secure path into employment.



The high percentage of young people moving from dual training into work makes this system particularly attractive to many countries, as underlined by the latest European statistics: on average, only 6.5% of young people were seeking employment in Germany in 2015, compared with an average of 16.1% across the 28 countries of the EU. Over the same period, the demand for skilled workers from German companies operating internationally remained high, particularly in their foreign locations.



The number of bilateral agreements on international collaboration in vocational training has been rising constantly since the 1970s, and the BMBF has signed bilateral cooperation agreements and Declarations of Intent with 17 countries. Within the EU, the BMBF agreed in 2012 on steps to increase youth employment and to further develop vocational training systems with the countries of southern and eastern Europe seriously affected by the economic crisis (Portugal, Greece, Italy, Latvia and Slovakia). The BMBF has contributed significantly to implementing the European Commission's European Alliance for Apprenticeships by launching dual training systems as pilot projects in cooperation with all EU cooperation countries. These show how practical training can succeed in the specific conditions of different education systems.

In all of its collaborative projects, the BMBF also succeeded in initiating a social partnership dialogue, convincing companies to provide training, establishing quality and standards in, for example, the training of trainers, and advising governments on the dual system.

International cooperation in vocational training touches on various policy areas ranging from education, economic and labour market policy through to foreign, development and immigration policy. In its 2013 strategy paper "One-stop International Cooperation in Vocational Training", the Federal Government, with the BMBF taking lead responsibility, defined

objectives for the first time for a more efficient and coherent approach to be adopted by the various national stakeholders in this field. A "Round Table" and an "Office for International Cooperation in Vocational Education and Training" were set up in the Federal Institute for Vocational Education and Training (BIBB) to implement the strategy.

The Agency for German Schools Abroad, an agency of the Federal Foreign Office (AA), offers the 445,000 students in its network target group specific advice on careers and study courses and supports cooperation with businesses and both German and foreign institutions of higher education. German Schools Abroad offers qualified vocational training based on the German model in 13 countries. A further dual training project at the Audi Hungaria school in Hungary supplements this network and serves as a model (see info box in 4.3).

Like beacons, the influence of German Schools Abroad spreads well beyond the particular region in which they are located. The German school in Quito, Ecuador exemplifies how these schools generate discernible lasting effects on the national education environment together with stronger vocational training cooperation between the host country and the Federal Republic of Germany.

As part of the “Schools: Partners for the Future” initiative launched by the AA, some 50 additional schools offering the German Language Certificate with a vocational focus are receiving support: specialised grammar schools (*Fachgymnasien*), vocational schools (*Berufsschulen*), specialised commercial colleges (*Fachhandelsschulen*), and hotel management colleges (*Hotelfachschulen*).

The coalition agreement provides for a doubling of the percentage of young people who complete a stay abroad during their education. In 2015, around 18,000 young people in vocational training and some 4,000 teachers and trainers benefited from a stay abroad under the Erasmus+ scheme.

Under the “Training without Borders” programme, the path to professional mobility can be opened up for companies and trainees even during in-service training, with mobility advisers supporting them as they undertake their stays abroad. The proportion of trainees spending time abroad is to be further increased. After being initially funded by the Federal Ministry of Labour and Social Affairs (BMAS) and the European Social Fund (ESF), the Training without Borders programme has been supported by the Federal Ministry for Economic Affairs and Energy (BMWi) since 2015. The programme will run until the end of 2018.

With a view to facilitating the acquisition of highly qualified personnel, the Federal Recognition Act of 2012 simplified and standardised the processes for evaluating foreign professional qualifications and opened them up to target groups that previously were not eligible.

Since 2014, corresponding Recognition Acts have come into force in all 16 *Länder*. The fact that 96% of the total of over 44,000 requests for recognition of professional qualifications submitted in 2012 and 2014 in the country as a whole received a positive response shows the great potential of the Act as an instrument for securing the supply of skilled labour.

Germany has achieved the education policy objectives set for the Europe 2020 strategy. Its 9.5% school drop-out rate even places it below the 10% target. In the 30-34 age group, 42% have completed some form of higher education or hold a comparable qualification



(including post-secondary, non-tertiary secondary education including education in evening classes, adult education colleges and specialist technical secondary schools). Germany is thus above the target of 40%.

The EU Member States are working together in the area of education to enhance Europe’s standing as an attractive location for education and training and one that can compete at global level in this field. The Education and Training 2020 (ET 2020) strategy offers a framework for this and was the object of a mid-term review in 2015. Cooperation in education at the European level also prioritises greater transparency and the recognition and equivalence of qualifications and learning outcomes. For this reason, Germany supports the implementation and optimisation of tools for transparency and the recognition of qualifications, such as the European Qualifications Framework



(EQF), the Europass, or the European Credit System for Vocational Education and Training (ECVET).

Collaboration with emerging and developing countries

Germany has been a long-term partner of emerging and developing countries as they build up and expand their education, scientific and research systems. More and more countries are recognising the importance of education, science and research for stable economic development. Between 2011 and 2015, the AA made approximately EUR 600 million available annually for strengthening collaboration with emerging and developing countries in science and research. In addition, the Federal Ministry for Economic Cooperation and Development (BMZ) supports higher education with approximately EUR 50m per year through programmes

aimed at supporting individuals (scholarships and measures aimed at alumni), at supporting partnerships with institutions of higher education and the management of such institutions. We are witnessing the development of a global knowledge-based society.

As an example, a focal point of collaboration over the last few years has been the further expansion of bilateral institutions of higher education. Between 2011 and 2015, the BMBF invested over EUR 22m in collaborative projects in the field of higher education in Jordan, China, Vietnam, Egypt, Oman and Turkey. In addition, the AA made more than EUR 42m available over this period to support bilateral higher education projects, including scholarships.

The objective of all these measures is to embed the advantages of German higher education formats, including technical universities (*Technische Hochschulen*) and universities of applied sciences (*Fachhochschulen*) outside Germany for mutual benefit. The positive effects which the specific conditions of these bilateral projects achieve include better intercultural understanding and knowledge of technology and business-oriented issues and the creation of transnational networks among students and teachers.

Collaboration has intensified significantly since 2008, especially with those countries in which expenditure on education and research has been increasing dynamically over the last few years (the aspiring science nations). This is illustrated by, among other things, the significant increase in the BMBF's expenditure on supporting projects with partners from developing and emerging countries (countries recognised by the OECD as recipients of development aid: the "ODA list"). In 2010, this expenditure amounted to a total of EUR 79m but had risen to EUR 150m by 2015. This increase secures Germany's long-term commitment to the partner countries while allowing Germany to benefit from the dynamic innovation systems in those countries.

A further focus is on collaboration with the continent of Africa. Based on the Federal Government Policy Guidelines for Africa, adopted in 2014, cooperation with this region in education, science and research has been backed by numerous structural measures. Between 2011 and 2015, the BMBF on its own made

approximately EUR 206m available for research projects with African partners. Funding for this purpose has more than quadrupled over this period, rising from around EUR 12m in 2005 to some EUR 58m in 2015.

Collaboration with the aspiring science nations is often particularly complex. This offers new opportunities for trans-European cooperation. This will allow the resources and experience of each EU state to be pooled and to play a part in the creation of stable and long-term collaboration with the partner countries and/or regions. Since 2009, the EU and its Member States have built joint bi-regional collaborative relationships with the African Union (AU), the Caribbean and Latin American states and India.

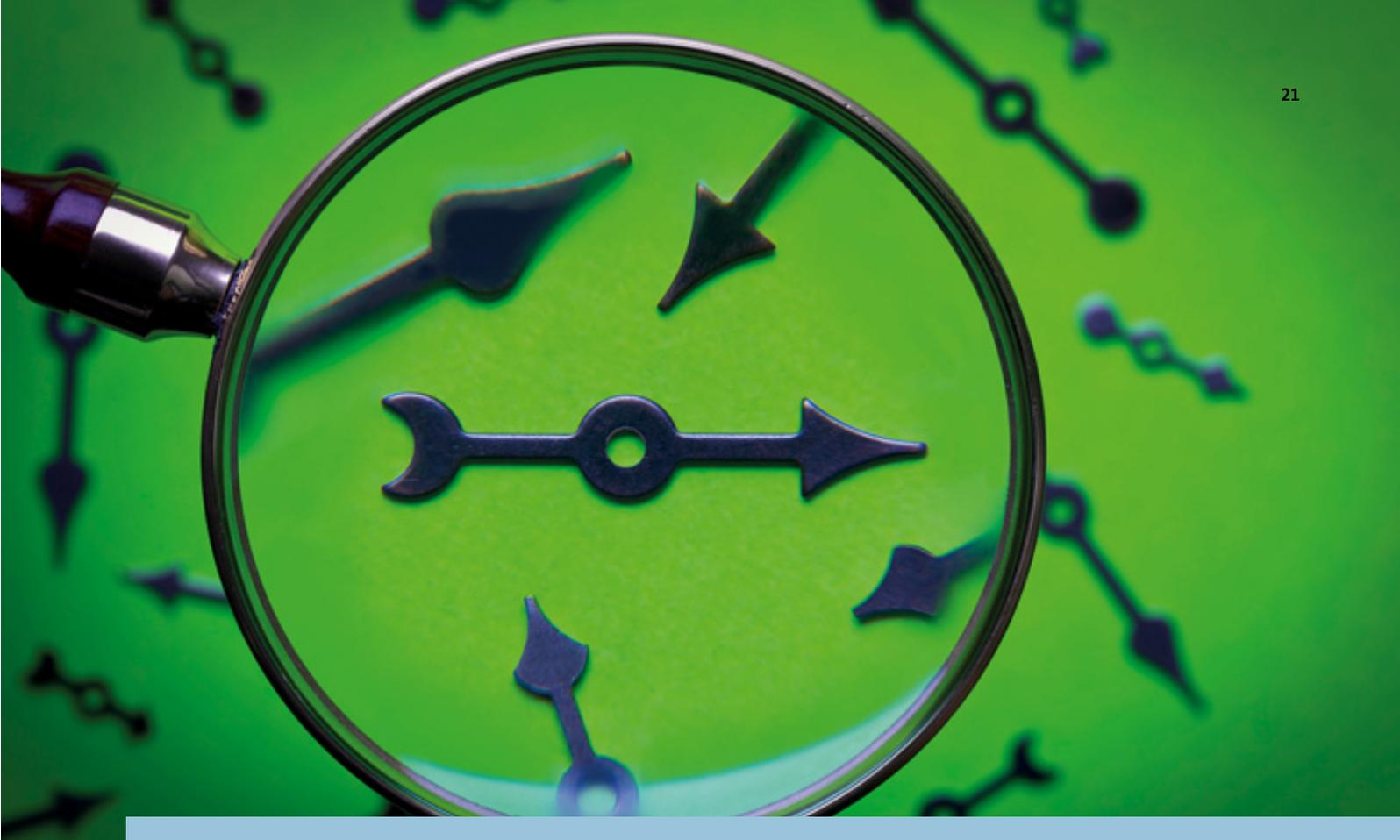
The central pre-condition for a partnership arrangement is a common understanding and the application of good scientific practices. In this respect, international scientific umbrella organisations have made important progress over the last few years. In particular, the founding of the Global Research Council (GRC) in 2012 fulfilled an important pre-condition for the worldwide dissemination of standards for scientific work. In hosting the GRC meeting in 2013, Germany underlined its commitment to worldwide partnership in research in this area.

Jointly developing solutions for global challenges

It is an undisputed fact that worldwide cooperation in education, science and research is required to meet global challenges, and there are two objectives that must be achieved to do so: firstly, create a recognised evidential basis for the necessary political decisions, and secondly, develop concrete measures that extend from the technological domain through to social innovations.

The European Commission has estimated that over EUR 3bn of public funding was and will be needed over the period from 2002 to 2016 to support measures coordinated at the European level (ERA-NETS, measures under Art. 185, JPIs). Between 2009 and 2013, the BMBF alone spent some EUR 470m on national measures in support of European transnational cooperation.

Since 2008, Germany has coordinated with its partners at European level under the Joint Programme Planning scheme in order to pool efforts to respond to global challenges. As part of this, Germany is participating in nine out of the ten current JPIs and has to date spent around EUR 30m on transnational calls, with another EUR 25m planned.



2.2 Trends and challenges

The worldwide trends in education, science and research that underlie the development of the 2008 strategy have been consolidated in the last few years. The further development of the strategy is based on these trends.

Internationalisation of science remains dynamic

Expenditure on education, science and research has risen in the last few years across the world. New stakeholders and potential partners for cooperation are entering the global stage. Students and researchers are more mobile than ever and more ready to cross national borders.

In each of the G7 countries, the number of scientific publications rose by no more than about 4% between 2008 and 2014. In the four G20 countries Turkey, China, Brazil and South Korea, however, the figure was over 7% and was at least 6% in the remaining G20 countries (with the exception of Saudi Arabia).

If the trends seen in the last few years continue, an estimated 138,000 foreign scientists will be living in Germany by 2020. At the same time, approximately 77,000 German scientists will be working abroad.

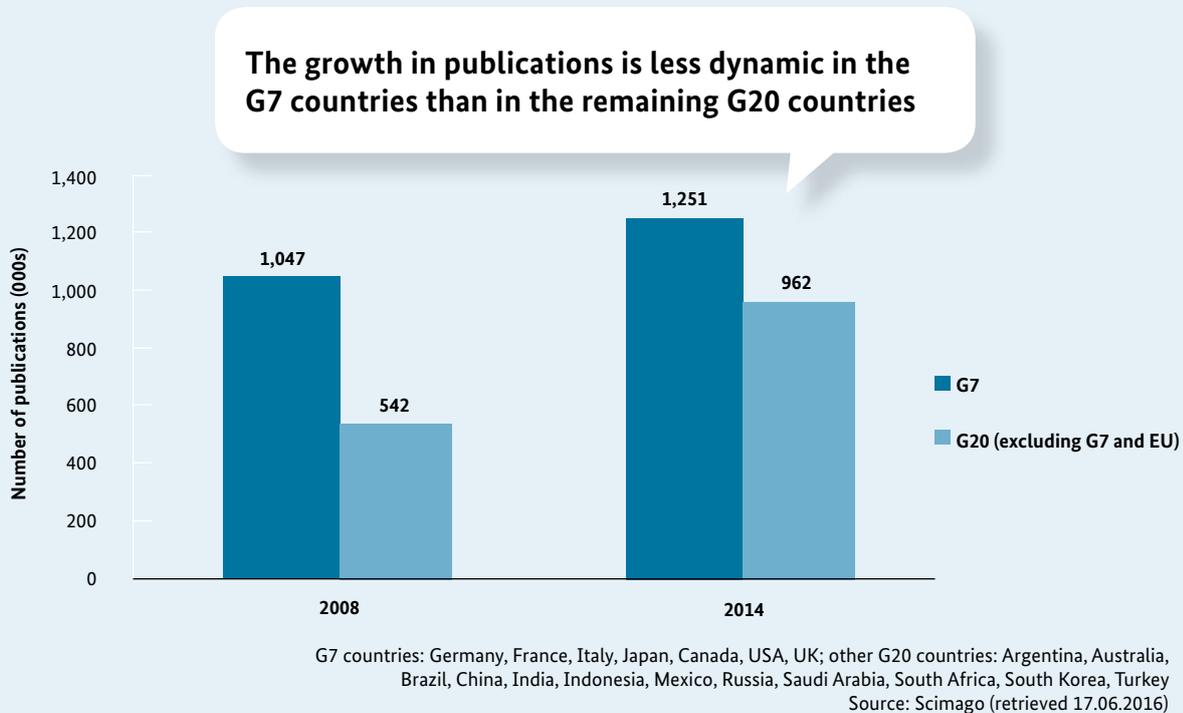
International joint publications will likely account for over 50% of all German publications.

Rising global competition for knowledge and markets

Innovation and production processes are increasingly taking place in global value chains that alter the production conditions and role of individual locations. In this process, value chains are encompassing significantly more countries and economic regions than in the past and are increasingly extending into the services sector. This is leading to growing intensity in competition between individual locations. With the rise of global value chains, access to sources of knowledge and integration with international innovation processes are increasingly becoming the important factors.

26% of the value creation for goods exported from Germany currently occurs abroad. Inputs imported from abroad are therefore a significant factor in the

Figure 6: Growth in the number of publications in G7 and G20 countries (excluding G7 and EU)



success of goods exported from Germany to the world market, and the Federal Government believes that this trend will strengthen in the coming years. In this world of increasing transnational division of labour, Germany is therefore critically dependent on cooperation with international partners.

It can be assumed that R&D capacity will increasingly migrate to Asia. China's expenditure on R&D in absolute figures amounted to USD 336bn in 2013, putting it immediately behind the US with USD 457bn. In the same year, Germany spent USD 101bn. Under the motto of 'indigenous innovation', the Chinese government intends to move from 'Made in China' to 'Invented and Designed in China'. In addition to massive financial investments, structural reforms and the building of international partnerships will contribute to the modernisation of the innovation system. Making use of the rapid growth of knowledge taking place in Asia, in particular, to secure Germany's competitive position requires the further development of international scientific cooperation with a focus on innovation.

The increasing complexity of collaboration

The number of countries that can be considered as possible partners for cooperation at a high level in education, science and research continues to grow. The complexity of the system changes and the dynamics of economic, ecological and social disruption and challenges that we face in the 21st century continue to exercise considerable pressure for change in the selection of partners and in the form and nature of cooperation, given the tension between cooperation and competition ('coopetition').

Germany will in future be obliged to adjust more radically to widely varying and sometimes volatile conditions when cooperating with a whole range of emerging countries. In this context, cooperation in education, science and research is also exercising a growing influence on bilateral and multilateral relations between states. By promoting freedom of research and teaching as well as the exchange and training of future elites, education and science can make a contribution to crisis prevention and resolution as well as to efforts

to bring about transformation. Cooperation in science facilitates networking as the guiding principle of modern international politics. It leads to the consolidation of relationships with strategic partners and aspiring powers, and supports cooperation in the political, social and economic spheres.

Many new developments have emerged since 2008

The European Research Area is deepening

Europe makes up 7% of the world's population and currently produces some 19% of global economic output. Europe still accounts for almost 25% of the worldwide generation of knowledge. R&D expenditure across the world rose by 30% between 2007 and 2013, while Europe's share in worldwide R&D expenditure fell from 26.2% to 22.7% over the same period. These are signs that the regions outside Europe are making growing contributions.

Europe's competitiveness and its future viability will continue to be shaped by the strength of its R&I. The ERA is the framework for the joint research policy efforts of the Member States and the European Commission and has developed from an originally abstract idea into a factor that increasingly determines and shapes national and European research policies. How the ERA develops over the coming years and how it reacts to new opportunities, especially digitalisation, will therefore be of enormous importance.

The EU's external relations in the fields of education, science and research are growing in intensity, quality and scope. Germany must make an active and continuous contribution to shaping this commitment to ensure that its national interests are adequately served. In this process, a balance must be struck between the EU's policy towards third countries and Germany's national policy.

The importance of research in United Nations programmes is rising

The Federal Government supports international programmes of the United Nations (UN), which depend in part on R&D. Some examples are the Global Framework for Climate Services (GFCS) under the aegis of the World Meteorological Organization (WMO) and the Sendai Framework for Disaster Risk Reduction coordinated by the United Nations Office for Disaster Risk Reduction (UNISDR). The associated challenges can only be tackled through international collaboration in R&D. The departmental research institutions play a special role in this regard due to their direct involvement with the consultation and decision-making structures of the relevant UN organisations. However, a commitment from all areas of the research environment in Germany is also essential.

The Federal Government's Internationalisation Strategy is aimed at reinforcing and focusing the contributions to international programmes. This enables rapid and effective integration with the international research environment. Germany's contributions will thus become more visible, more effective and more focused. In addition, programmes of this type offer an excellent arena for capacity development and for fostering young research talent. One example is the successful internationalisation of the Young Earth System Scientists (YESS) Community.

Digitalisation is becoming a determining factor

Digitalisation is increasingly permeating all areas of industry, science and society. The dynamic nature of international collaboration is inseparably linked with the digitalisation of the world. Digitalisation drives innovation, facilitating transnational access to knowledge while at the same time opening up new possibilities for international cooperation in education, science and research.

The scope of the associated topics is huge. It includes transnational participation, communication and cooperation in research and publication processes and is only inadequately captured by terms, taken from the European context, such as 'Science 2.0', 'eScience', 'Open science', 'Open research' or 'Open Innovation'. The increasing use of wikis, blogs and

R&D-specific social networks by scientists for their work is just one example of the innovative forms of cooperation that are opening up. For example, the provision of standardised, structured data in electronic form in the health sector supports both secure data collection and the ability to answer research questions.

Adopting a holistic approach in the knowledge triangle of education, research and innovation

Modern knowledge-based societies are increasingly making efforts to develop holistic approaches in their politics that integrate the various components. Synergies in the knowledge triangle of education, research and innovation are increasingly used to achieve gains in quality and effectiveness. It is the only way to secure the potential for prosperity to be found in education, science and innovation while contributing to the resolution of societal challenges.

The European research and innovation programme Horizon 2020 is a good example of an international programme that links innovation and research. A further example of the successful interaction of the elements in the knowledge triangle in international collaboration is the Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT). KICs are autonomous legal entities, established for the long term, each comprising a number of international partners drawn from industry, higher education and non-university research bodies. KICs exist for the subject areas of energy, information and communication technologies, climate, health and raw materials.

Since 2014, the European education programme Erasmus+ has offered the option to fund collaboration in strategic partnerships between, for example, entrepreneurs and institutions of higher education. Against this background, the emphasis will in future be to increase the integration of the knowledge triangle and to network knowledge clusters – either with each other or with other instruments – at a bilateral, European and international level.

Integrating refugees and preventing the causes of migration

In 2014, there were some 60 million refugees worldwide – more than at any time since the Second World War. It is a global task to offer safe shelter, food and health care to these people seeking protection. In the context of this strategy, national integration measures and combating the causes of displacement in the regions of origin are both of equal importance.

The middle and long-term challenge at the national level is to integrate a large number of – overwhelmingly young – people into society and the labour market. Integration through education is paramount in this context. Since 2015, the Federal Government has launched numerous initiatives aimed at improving the integration of refugees into training, study and work. These measures range from language development, identifying skills and the recognition of qualifications, careers advice and integration into vocational training through to facilitating access to higher education.

In addition to a large increase in funding for integration measures, the Federal Ministry of Labour and Social Affairs (BMAS) has, among other measures, introduced a regulatory instrument for job-related German language development, created the conditions for 100,000 job opportunities annually for refugees



and increased the funding for support programmes that also serve to integrate refugees into the labour market. In addition, the opportunities were improved for refugees to take up work and to access educational funding and other instruments aimed at the active support of employment.

Working with trades organisations and the Federal Employment Agency, the BMBF has launched a programme that is intended, through early careers advice and preparation, together with a comprehensive qualification and care system, to enable up to 10,000 refugees to get a start in training. In the field of higher education, the BMBF is supporting the identification of technical and language skills in refugees wanting to take up study as well as the expansion of capacity at preparatory colleges (*Studienkollegs*) and similar institutions by up to 2,400 places per year. Refugees have better prospects in the labour market if their professional qualifications are recognised. The Recognition Act creates good prospects for this in that, for instance, qualifications can be established even if all the necessary documentation is not available.

Companies wishing to integrate refugees into work and training are informed, advised and put in touch by means of various measures taken by the BMWi, such as the Centre of Excellence on securing skilled labour (*Kompetenzzentrum Fachkräftesicherung*), the refugee recruitment advisers (*Willkommenslotsen*) or the “Companies integrating refugees” network (*Unternehmen integrieren Flüchtlinge*).

One consequence of many crises is that the path to education and science is barred to countless people who were forced to leave their homes as a result of war and persecution and have no access to education facilities. Germany is playing its part in offering refugees sustainable prospects for the future in the crisis region and improving scientific structures on the ground. To this end, the AA is funding scholarships for refugees in their country of first admission. As a result, over 4,800 young people were able to begin studies in 42 countries in 2016.



In addition, the Philipp Schwarz Initiative of the AA is making available a special programme to host threatened scientists at German universities and research institutions. This is necessary because both scientists and scientific institutions are particularly sensitive to societal change and are frequently severely affected by destabilisation. Study and research require a number of preconditions, such as security, resources and long-term planning. As forums for liberal thought, universities are also an important factor in societal change.

The transnational measures taken by the Federal Government in education, science and research have at least an indirect stabilising effect in the target countries. Their objective is always also to create sustainable structures in the developing and emerging countries that offer a future to the local population. This includes the joint development of the education system (And, in this context, the vocational education system in particular) as well as the construction and strengthening of individual educational facilities. Knowledge-driven economic growth, leading to new prospects and employment opportunities, can be strengthened by the expansion of research and innovation systems.



3 Guiding principle: “International co-operation: networked and innovative”



The internationalisation of the German science and innovation system has developed considerable momentum over the last few years. Both the state and the private sector have made many resources available to secure and extend the scope of Germany’s international competitiveness. German stakeholders from the worlds of science, business and politics are heavily engaged in the international arena and numerous initiatives have been launched. Internationalisation is now firmly rooted in politics, science and business.

The pace at which a globalised world moves demands constant adaptation and improvement. At the same time, the number of countries that can be considered for high-level partnerships with Germany in the fields of education, science and research continues to rise.

We cannot adjust to these conditions through primarily ‘more’ cooperation or deploying ‘more’ resources. Rather, it will be primarily a question in the coming years of ‘how’ Germany wants to cooperate with foreign partners.

How do we want to shape international collaboration against the background of new trends and challenges and the diversity of relationships in a multi-polar world? How can we together make more of the commitment of the individual German stakeholders in international cooperation, whether from scientific and research institutions or innovative companies, and SMEs in particular? How do we create the necessary critical mass? How does the internationalisation of higher education, science and training affect Germany’s bilateral and multilateral relationships? How do we network more effectively? These questions are especially important, given that the resources of the stakeholders are finite.

Against this background, the Federal Government’s guiding principle for the further development of the strategy is “International cooperation: networked and innovative”.

Networked and innovative cooperation is:

- **Focused:** International collaboration in education, science and research is consistently geared to achieving strategic objectives.
- **Effective and efficient:** Synergies between the different activities of the individual stakeholders are used in order to create the greatest possible effect. Networking is pursued at both the national and international level.
- **Sustainable:** Cooperative ventures are not measured by their short-term effects; they should have a long-term impact.

The Federal Government’s overarching objective in this strategy is to bring the different levels of action and the different stakeholders even more closely together. The Federal Government will therefore step up cooperation between the federal ministries on the international stage in the coming years through measures such as intensifying the development of ‘synergy projects’- (cross-departmental initiatives). Various synergy projects and platforms of this type that already exist are highlighted in the strategy as examples.

In addition, the Federal Government is setting up a round table to bring key German stakeholders together. This body, at State Secretary level, is intended to facilitate the regular exchange of information and to discuss strategic questions related to international cooperation in science and innovation. It should also perform such tasks as identifying where future action is needed in the form of further cross-departmental initiatives (synergy projects). Our overall objective is to achieve a new level of quality in international collaboration by strengthening the coordination and networking of Germany’s commitment in R&I.





4 Objectives and measures



4.1 Strengthening excellence through worldwide cooperation

Scientific excellence is the result of ability, passion and perseverance. It thrives on sharing and competition between the world's best minds. Striving for excellence, therefore, also means striving to bring together the best people in the world and the best of the individual systems. This in turn requires a national scientific and research landscape based on excellence, something fundamental to the attractiveness of a location.

The Federal Government has declared its aim to further consolidate Germany's pre-eminent position as an internationally attractive location for science, research and innovation. This requires, among others, a reliable and continuous high level of funding. Against a background of considerable progress over the last few years, the Federal Government, together with the *Länder* and the private sector, will continue to commit itself to achieving the target of investing 3 % of GDP in R&D.

The Federal Government will continually work toward the further removal of barriers to the international mobility of scientists. The aim is that more qualified foreign students and scientists should come to Germany. They should be integrated into academic life and bring their expertise into German companies.

We also want to ensure that the best of the German scientists currently working abroad are offered attractive options for continuing their work in Germany, both from the political authorities and from German scientific and industry circles. The German scientists who return from abroad should at the same time help to cover the increasing demand for specialised staff by German businesses.

The further development of a welcoming culture based on positive values is also part and parcel of creating attractive living and working conditions. This is part of what makes a modern, tolerant society that is open to the world.

Germany's commitments in Europe, whether on a bilateral basis or at EU level, continues to be a key focus

of the Federal Government's activities. The Federal Government sees itself as the driving force behind the deepening of the ERA. Institutions and scientists from Europe will continue to be the most important partners for German researchers, and the successful participation of German stakeholders in the competition for European funding programmes remains an important indicator.

The Federal Government considers the meshing of their efforts at the national level with bilateral and multilateral, European and international processes and developments to be one of the key tasks of German stakeholders. This is not just a matter of taking national research and innovation programmes forward in a way that is compatible with international activities; we should also be systematically introducing national strengths into European, multilateral and international activities and processes and helping to shape them.



We will therefore ...

- **further increase international mobility**
- **create attractive, internationally competitive work and career conditions**
- **build and expand joint research infrastructures**
- **support and expand participation in Horizon 2020**
- **make the European Research Area a reality**

Further increase international mobility

International comparison shows that, measured by the total number of international students, Germany is the fifth most popular host country for higher education studies. We want more qualified foreign students and scientists to come to Germany and more Germans to gain experience abroad. The Federal Government will work towards the systematic removal of barriers to international mobility.

- There were 320,000 foreign students in Germany in 2015. We want this figure to rise further, to 350,000 by 2020.

- The development and improvement of a culture of welcome is the objective of the Federal Government's skilled labour concept ("Integration and qualified migration" pathway) and the demographic strategy as updated in 2015. In future, the Federal Government will communicate more strongly the benefits of the immigration of highly qualified people for society as a whole and in particular for the solidarity-based social welfare systems. At the same time, the high proportion of international students and scientists in higher education institutions is an opportunity for a large part of the population to gain some positive intercultural experience first-hand. Through the DAAD's AA-funded Scholarship and Assistance Programme (*Stipendien- und Betreuungsprogramm – STIBET*), we are supporting the culture of welcome in academic institutions and the integration of foreign students by creating a better environment at higher education institutions. This is being done, for instance, through specialist study support and tutoring programmes aimed at promoting integration.

- Together with the *Länder*, we are pursuing the objective of enabling domestic students at German institutions of higher education to gain international experience more frequently via such routes as structured study courses with periods spent abroad and joint or double degrees. We have set ourselves ambitious mobility targets up to 2020. These exceed the European targets and make an important contribution to the European Higher Education Area: *"The Federal and Land authorities consider realistic the objective that every second graduate from the higher education system should have gathered some study-related experience abroad and that every third graduate can point to a period abroad lasting at least 3 months and/or 15 ECTS credits. This concerns mobility in all three Bologna cycles."* (Strategy of the Federal and *Länder* Ministers of Science for the Internationalisation of Higher Education Institutions in Germany, 2013.)
- We are committed to intensifying the cross-linking of mobility measures in support of the next generation of scientists between German research and intermediary organisations. The DAAD and the Alexander von Humboldt Foundation (AvH) continue to occupy a central role in the continuous

The European Higher Education Area or “Mobility à la Bologna”



When Europe adopted its Mobility for Better Learning strategy in 2012, it committed itself to further increasing the mobility of students, young scientists, teachers and other higher education staff. 48 countries and their institutions of higher education in the European Higher Education Area must now draw up internationalisation strategies and further eliminate barriers to mobility.

The Federal Government supports structured periods abroad during Bachelor and Masters studies through its Bologna mobility package, which is funded by the BMBF with EUR 17.5m mainly through the ‘*Bologna macht mobil*’ component of the package.

expansion of international mobility at all levels of the science system. In 2015, the DAAD funded more than 127,000 students and scientists, making it the largest international academic exchange organisation in the world. It is expanding academic mobility under new cooperation programmes, such as a specialist teacher training centre in East Africa and a centre for German and European studies in Brazil. The AvH combines individual funding of exceptionally well qualified scientists with their lifelong integration into a worldwide network of excellence using established funding instruments, such as Humboldt research scholarships and research prizes. World leaders in all areas of science are

Both the Federal and *Land* authorities, as well as institutions of higher education, students and social partners, are embedded in the process of shaping the European Higher Education Area.

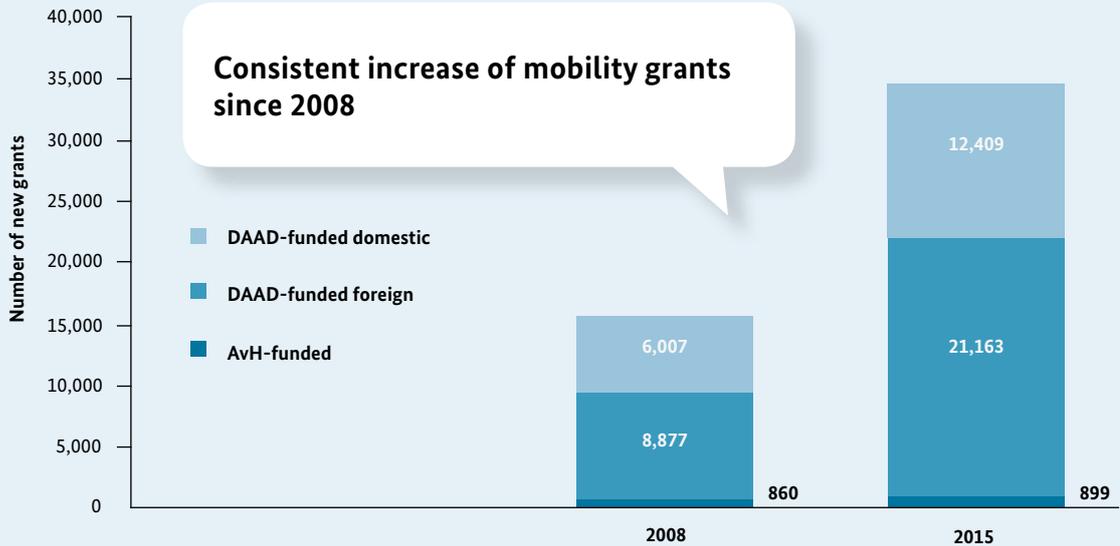
At their meeting in Yerevan in May 2015, the education ministers of the European Higher Education Area adopted a large number of measures for the next three years. In addition to the accession of Belarus as the 48th member state, other measures agreed included improvements to the “Standards and guidelines for quality assurance in the European Higher Education Area” (ESG), which govern quality assurance in joint European programmes, and to the ECTS user manual.

The accession of Belarus has led to a call for the comparable and consistent implementation of all the Bologna reforms in other countries, some of which are struggling to implement them. This objective is also being supported through concrete measures such as peer learning, seminars, workshops and conferences. Both the Federal and *Land* authorities will be actively involved in this process.

brought to Germany through Alexander von Humboldt professorships, thus enhancing the international competitiveness of the institutions as well as that of the research location as a whole.

- We will coordinate national measures in support of mobility more closely at European level. We will continue to fund the expansion of information portals and the provision of information on professional, career and living conditions as well as on provision for old age, including such elements as “Make it in Germany”, “Study in Germany” and the European “Euraxess” initiative.

Figure 7: Mobility funding by AvH and DAAD (2008–2015)



Source: AvH Annual Report; DAAD

- More German researchers should make use of mobility grants available under the “Marie Skłodowska-Curie” programme in Horizon 2020. To this end, we will tailor the advisory services and supplement them with existing national mobility measures.
- We will work to promote a more extensive exchange between Germany and the BRICS countries (Brazil, Russia, India, China and South Africa) as well as other aspiring science nations in Asia and Latin America.

Cooperation between departmental research institutions and European universities

The Federal Waterways Engineering and Research Institute (BAW – Bundesanstalt für Wasserbau) has been cooperating with universities in Europe for some years under its “Competence for waterways – Today and in the Future” programme. The BAW’s scientists carry out all or part of their research work at these European universities, where they also obtain their doctorates. The research work in question covers waterway engineering topics in the fields of constructional, geotechnical and hydraulic engineering. The Robert Koch Institute (RKI) has coordinated the European Network for Imported

Viral Diseases (ENIVD) for a number of years. Specialised laboratories working in the field of virology in a whole range of European countries use this network to exchange their best practices experience, the results of their work and diagnostic procedures. Several of the laboratories cooperating in this way are located within medical or natural science faculties of European universities. Departmental research institutions frequently cooperate through joint European research projects, such as within the framework of Horizon 2020.

Create attractive, internationally competitive work and career conditions

Career paths at German universities need to offer greater scope for planning and more transparency.

Responsibility for appropriate further development of career structures lies essentially with the universities and *Land* authorities.

- We advocate attractive, internationally competitive work and career conditions. To be internationally

Internationalisation of the pacts between Federal and *Land* governments

Both Federal and *Land* governments have stressed the importance of internationalising scientific organisations in the further development of the Pact for Research and Innovation. These organisations should prioritise the expansion of cooperation, both at the European and international levels. Special emphasis is placed here on the active shaping of the ERA and participation in Horizon 2020.

The international involvement of participating scientific organisations will be assessed both qualitatively and quantitatively as part of monitoring for the Pact for Research and Innovation. The indicators used will be successful in attracting external funding as well as exemplary projects of great scientific influence.

The Excellence Initiative promotes cutting-edge research while aiming to gain international visibility for the best that university and research domains have to offer. On 16 June 2016, the Federal Chancellor and heads of the *Land* governments adopted the Excellence Strategy for an indefinite period. The strategy aims to support leading university research in order to strengthen Germany's position as a location for science and its international competitiveness. EUR 533m will be available annually for this from 2018 onwards under two funding lines. The "Clusters of Excellence" funding line will make project-based funding available in internationally competitive fields of research in universities or groups of universities, "Universities

with Clusters of Excellence" can apply for a university allowance, designed as a strategic boost for strengthening the institution's governance and strategic orientation. An annual total of some EUR 385m is available under this heading. The Universities of Excellence funding line is intended to be used to strengthen universities, as individual institutions or as groups of universities, and to enhance their positions as international-level leaders in research. This heading will see the first application of the new constitutional regulation by which the Federal Government and the *Land* in which the university is situated can jointly provide long-term financing for a university. An annual total of EUR 148m is available under this category. The science-based process remains in the hands of the German Research Foundation and the German Council of Science and Humanities.



competitive, it is particularly important to establish tenure-track assistant professorships.

- In amending the Academic Fixed-Term Contract Law, we have improved the conditions of work for young scientists in a sustainable way. The amendments have improved time limit regulations and are intended, in particular, to ban the setting of inappropriate time limits on contracts. Our intention here is to counter undesirable trends in how contracts are time-limited, without at the same time prejudicing the flexibility needed in the scientific environment.

Build and expand joint research infrastructures

High-performing research infrastructures are at the heart of European and international research policy. This is where top-class scientific research takes place and where scientists work on questions that could lead to tomorrow's innovations. Research infrastructures are centres for the training and development of scientists and for creating understanding between nations, thus opening up a wide range of opportunities for collaboration with partner countries.

- We have established the Roadmap Process for research infrastructures as a strategic instrument for defining research policy priorities for future investment. This process is the successor to the Roadmap for Research Infrastructures. It is intended to create the financial transparency and the certainty as regards planning that is needed, both for national projects and for participation in European and global research infrastructure projects. Factors such as the scientific and technical complexity and the high costs involved mean that planning, constructing and operating research infrastructures in certain fields is today only feasible through European or international cooperation.
- We will continue to actively play our part in shaping the work of the European Strategy Forum on Research Infrastructures (ESFRI), particularly as regards the further development of the so-called ESFRI Roadmap. We support a review and, if necessary, revision of the evaluation and decision-making processes as well as the criteria for accepting infrastructure projects. The projects currently running under the ESFRI Roadmap cover the whole range of disciplines, from the natural sciences through to the humanities and social sciences. There is strong German representation in all six of the projects in the latter category.
- Germany will also continue its strong commitment to long-term provision of the Copernicus Services. Copernicus supplies extensive earth observation datasets and outputs, such as remote sensing, computer modelling and in-situ measurement that form an essential foundation for European and international research.
- We want to integrate national processes more closely and intensively with the work on research infrastructures underway in the framework of the OECD and the G7. Germany initiated preliminary discussions in 2015 between the OECD/Global Science Forum (GSF) and the Group of Senior Officials on Global Research Infrastructures (GSO) founded by the G8 science ministers in 2008.
- The Federal Government will play an active role in giving shape to the European Open Science Cloud. The task here is to create the optimal conditions for capturing data and knowledge content, long-term storage and accessibility across borders and disciplines. A European initiative should build on existing national activities and take account of experience from international initiatives, such as the Research Data Alliance. It is important here to clarify the necessary preconditions, for example in the form of uniform standards.

The X-ray free-electron laser

Scientists want to use very high intensity X-ray laser pulses to penetrate far into the finest structures of complex materials, to explore biochemical and physical structures not currently understood at the nanoscale. To do so, they are planning an X-ray free-electron laser, referred to as the European XFEL. Commissioning of the European XFEL large-scale research facility in Hamburg is planned for 2017. It will achieve a light intensity billions of times greater than the best conventional X-ray sources. This is a decisive advantage for many experiments: biologists can capture detailed images of cell

components or viruses, which are crucial for diagnostics and the development of medicines. Chemists can film reactions to obtain a slow-motion view of the interaction between individual atoms. Physicists and materials scientists can study the precise structure of nano-materials – important sources for future uses, such as more effective solar modules.

Current XFEL participants are Denmark, Germany, France, Greece, Italy, Poland, Russia, Sweden, Switzerland, Slovakia, Spain and Hungary. Construction is

being financed by the Federal Government and the *Land* governments of Hamburg and Schleswig-Holstein, with the BMBF providing some EUR 760m of the total. On top of this, the BMBF is funding joint research projects in which German universities and research institutions are developing novel tools and technologies for the European XFEL.



Support and expand participation in Horizon 2020

The Federal Government is urging German stakeholders to participate in Horizon 2020 at the same level – or more – as they did in FP7. In this context, we want both to simplify the application process and increase the prospects of successful applications.

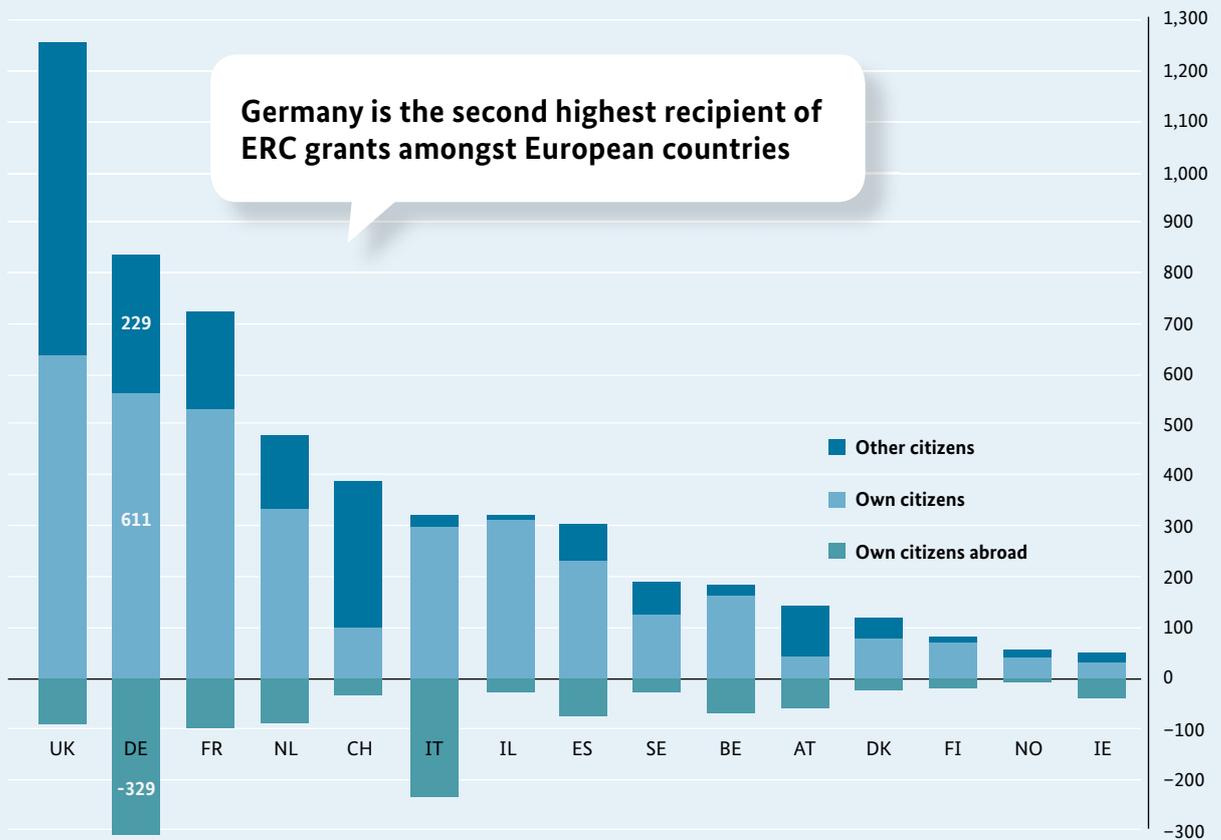
- We increasingly favour the use of incentives. We are therefore supporting stronger participation by German universities of applied sciences in Horizon 2020 through a competition for ideas on the development of EU strategies and the financing of activities during the application stage.
- We favour strengthening of the ERC and support the efforts of German research institutes and institutions of higher education to attract ERC grantees. Since its foundation in 2007, under the umbrella of the

Framework Programmes for Research, the ERC has become a success story. It is now recognised throughout the scientific community as an excellent instrument in the competition for scientific excellence at European and international levels.

- Through the network of National Contact Points, we will continue to provide targeted advice and information to German scientific organisations on the funding available within Horizon 2020. In this context, we will pay increased attention to the need for information on cross-cutting topics such as so-called ‘innovative procurement’. With respect to the cross-cutting topic of gender equality, the BMBF is financing a contact point on the subject of “Women in EU Research”.

- In addition to the 22 National Contact Points, we are providing further advice centres on subjects such as the EIT and on international cooperation with third countries (countries that are neither members of the EU nor associated with Horizon 2020).
- We are working within the framework of the joint federal working group set up in 2014 on better co-ordination between Horizon 2020 and the European Structural and Investment Fund. Among other things, the Fund makes money available for research and innovation activities in the EU Member States. We are committed to creating greater transparency as regards opportunities for joint applications and improving access to possible funding for potential applicants.

Figure 8: Acquisition of ERC grants 2007–2014



ERC grants under FP7 and Horizon 2020 by country of the guest institution and nationality of the principal investigator; Starting, Consolidator and Advanced grants combined

Source: eCorda

Make the European Research Area a reality

Germany's 2014 national ERA strategy set a new standard in Europe. At a conference on the ERA in October 2016, the BMBF submitted a first progress report on what had been achieved at national level and presented additional proposals for the further development of the ERA.

- At the European level we will continue to contribute actively to shaping the ERA. We will accordingly work with the other Member States on implementation of the European Research Area ERA Roadmap, based on processes and measures driven by the Member States.
- Together with other Member States and the European Commission, we advocate closer integration of the core dimension of Open Science into current ERA initiatives. The restrictions that apply to market-related research should be taken into consideration just as much as the broad range of available initiatives driven by scientific circles. In addition, the aspect of scientific integrity as a foundation for scientific excellence and trust in research takes on new relevance. We see the main responsibility as lying with the scientific stakeholders themselves.
- In coming years, we will leverage the positive development of the ERA for deeper collaboration at bilateral and multilateral level with other Member States. We are also placing greater emphasis on the integration of national and European processes

European Research Network for Coastal Protection

The BAW is working with 17 European partners in the joint European research project RISC-KIT (Resilience-Increasing Strategies for Coasts – toolKIT) on tools for increasing the protection and the resilience of coastal regions (an EU research project under the FP7). The

topics covered in this project include an understanding of the current and historical situation in the context of a region, the assessment of the risk level for a coastal region for present and future risk probabilities, the identification of critical hot-spot regions with a higher

risk level, the designing of disaster risk reduction plans including appropriate preventive measures, the containment of risks and the building of trust and societal acceptance for such measures. In this way, effective disaster prevention systems that have a strong social basis can be attained and become part of the culture. The development of methods and tools for reducing risks and increasing the resilience of coastal regions requires an interdisciplinary and networked approach at European level.



through macro-regional strategies (such as the Danube Region strategy).

- We advocate closer linkage between the activities of the European Higher Education Area and the European Research Area.
- Integration of the knowledge triangle at European level is growing in importance. For this reason, we will continue to support the EIT as a key stakeholder in this context.
- We attach high priority to the processes currently under way to develop a sustainable system of monitoring and advocate a transparent and robust system which should provide all stakeholders in Europe with the necessary guidance. This applies in particular to the monitoring of the ERA (the ERA Monitoring Mechanism – EMM) and its components, such as Open Science.

Synergy project: Franco-German University

The Saarbrücken-based Franco-German University (FGU) does important work for the promotion of German and French higher education and science. Founded in 1997 under an intergovernmental agreement, the university is currently funded on the German side with EUR 6.8m from the BMBF, the AA and the Standing Conference of the Ministers of Education and Cultural Affairs (KMK). On the French side, the FGU is supported by the French Foreign Ministry and the Ministry for Higher Education and Research. While it has the task of providing support for the mobility of students and young scientists from both countries, it also has the role of creating structures in Franco-German cooperation in higher education based on innovative models. This is expressed not only through their integrated study courses leading to double degrees, but also through their joint postgraduate education courses that are currently being provided in 22 Franco-German postgraduate schools. In addition, the strengthening of graduates' binational skills also contributes to the European Higher Education Area and the European Research Area.

176 institutions of higher education in the two countries are participating in the activities of the FGU. Between 2010 and 2015, the number of students enrolled in the funded binational

study courses rose from 5,000 to 6,200, a rise of 24%. The number of study courses itself rose from 128 to 166 (+30%) while the number of research projects being funded rose from 49 to 115 (+134%).

The success of the FGU has also had a knock-on effect on other bilateral projects run by Germany abroad, such as the founding of the German-Argentine University Centre.



Scientific organisations in alliance – selected projects

“Internationalisation of Universities” audit and re-audit (HRK)

The “Internationalisation of Universities” audit and re-audit of the German Rectors’ Conference (HRK) is helpful in advising and supporting its member universities on the process of strategic internationalisation. The audit



is a voluntary, independent and systematic analysis of a university’s internationalisation process. It provides its management with information on the performance and

effectiveness of its internationalisation measures and on opportunities for developing them further. The objective is to identify the university’s specific international profile and in this way ensure the sustainability of the internationalisation process. Previously audited universities can take advantage of the re-audit to benefit from external support during the implementation of their internationalisation objectives.

Another important objective of the initiative is that of creating networks to link the universities together. This is done through conferences and workshops on the one hand, and by disseminating examples of successful internationalisation practice on the other. In addition, by looking at the audits as a whole, conclusions are drawn as to the state of internationalisation in the entire higher education system. Based on these meta results, the project identifies any requirements for action or funding, which are then discussed with the responsible departments and funding organisations.

International graduate schools strengthen Canadian-German relations (DFG)

Excellence in research is based on the development of cooperation into new areas. One example of this is the development of the DFG’s International Graduate Schools (IGS) programme with Canada. In February 2011, the DFG successfully concluded an agreement with the Canadian National Science and Engineering Research Council (NSERC) to link the IGS programme with what

was then the new Collaborative Research and Training Experience (CREATE) programme. Up to that time, there had been no IGS in operation linking a German and a Canadian institute of higher education. In the five years since then, 13 German-Canadian IGSs have been set up. German and Canadian institutes began to focus much more attention on systematic, coordinated partnerships

upon announcement of the agreement. Six IGSs are currently being funded under the NSERC agreement. Seven IGSs, including two in the humanities, have developed out of personal contacts between researchers. The IGSs are selected in a highly competitive process within the general graduate schools programme. As a result of the science-based selection process and two-way movement of students (research periods lasting a number of months at the partner institution are a requirement for doctoral

students in both countries), excellent research is being established within long-term partnerships extending over multiple generations of researchers. One – desirable – side effect is the increased attention being paid in Canada to Germany as a location for science, as shown by the increased interest in cooperation both inside and outside the IGSs.

The Principles of Cultural Dynamics thematic network of the FU Berlin (DAAD)

The Freie Universität Berlin's Principles of Cultural Dynamics thematic network shows how existing collaborations can be best used, efficiently expanded and sustainably designed. The bottom-up network, founded by the Department of Philosophy and Humanities, has been funded by the DAAD since 2013 under the Strategic

sets, the École des Hautes Études en Sciences Sociales in Paris and the Chinese University of Hong Kong. It brings together students, young scientists and researchers rooted in different cultures and scientific traditions. New ideas and international projects emerge from the numerous meetings.



The network is so influential that universities in other countries want to join at their own expense. These include the National Research University Higher School of Economics in Moscow – this collaboration facilitating the opening-up of the east European region – and the Australian National University, rooted in the British tradition, which has opened up significantly towards Asia in the last few years.

By supporting the creation and expansion of strategic partnerships, the programme contributes effectively and specifically to the implementation of the internationalisation strategies of German institutions of higher education. Partnerships with other universities across the globe are used strategically to strengthen the competitiveness of the own university and to sharpen its profile.

Partnerships and Thematic Networks programme. In this network, which has become a model for further partnerships the university has entered into, the FU Berlin collaborates with five prestigious universities: the Hebrew University of Jerusalem, the Johns Hopkins University in Baltimore, Harvard University in Cambridge, Massachu-

Strategic collaborative projects of the Helmholtz Association with Israel (HGF)

Collaboration with Israeli institutions is a strategic priority for the HGF. The collaboration is thematically and institutionally diverse, and oriented toward the future.

One topic that should be mentioned in particular is the Helmholtz-Israel Cooperation in Personalized Medicine in which several Helmholtz centres have joined together with Israeli partners. The objectives of this collaboration are to investigate the causes and mechanisms involved in major wide spread diseases, such as cancer, cardiovascular disorders or infectious diseases, and the development of personalised approaches to diagnosis, treatment and prevention. The project links into long and successful cooperation between the BMBF and the Ministry of Science, Technology and Space (MOST) in cancer research. The German Cancer Research Center and a number of Israeli research institutes and universities will be collaborating in the project.

Another excellent example is the DESERVE (DEad SEa REsearch VENue) virtual institute, a joint project between Helmholtz centres and partners from Israel, Jordan and the Palestinian Autonomous Areas. Building on the expertise of Helmholtz centres in the disciplines of earth, water and atmosphere, the project is based in the Dead



Sea area and is cross-disciplinary and collaborative in design. The importance of cooperation with Israel is further underlined by the strategic partnership with the Weizmann Institute, which among other disciplines covers research projects in the field of laser physics. All these activities make a fundamental contribution to the support of young scientists, for instance in the framework of the cooperation between the Helmholtz International Research Schools and Israeli institutions.

Research infrastructures as a focal point of international cooperation (HGF)

The construction and operation of unique infrastructures across the world is one unique selling proposition of the HGF. The facilities offer national and international scientists excellent research opportunities. The Association makes a significant contribution to the further development of international facilities, such as the International Thermonuclear Experimental Reactor (ITER) fusion experiment in France or the Large Hadron Collider (LHC) particle accelerator at CERN in Switzerland. In addition, Helmholtz centres also operate measuring stations and laboratories in leading international facilities, such as at the National Labs in the USA

or institutes of the Chinese Academy of Sciences. Research ships, earth observation systems or polar stations are further elements of the important infrastructures the HGF builds and operates. These facilities are staffed with international research teams working on complex scientific problems. The development and provision of such research infrastructures reinforces cooperation between national and international stakeholders, such as the many visiting researchers who perform their scientific projects here.

Amazonian Tall Tower Observatory (MPG)

The ATTO (Amazonian Tall Tower Observatory), a joint German-Brazilian project, was initiated in 2009 and is intended to deliver ground breaking insights and provide the basis for improved climate modelling. At 325 metres, the tower rises above the boundary layer close to the ground and supplies information on approximately 100 square kilometres of rain forest. Participants in the joint project are the Max Planck Institute for Chemistry, the Max Planck Institute for Biogeochemistry, the Brazilian National Institute for Amazon Research INPA (Instituto Nacional de Pesquisas da Amazônia) and the University of the Amazon States (Universidade do Estado do Amazonas – UEA).

ATTO created a reference laboratory unique in the world for investigating the interactions between tropical rain forests and the atmosphere. The data generated at this new tower flows into models for forecasting climatic developments. The measurements emerging from ATTO will also help politicians in the future to refine environmental regulations and global climate goals. The project is financed on the German side by the BMBF and on the Brazilian side by the Federal Ministry for Science, Technology and Innovation and the Amazonas state government.



International Max Planck Centres (MPG)

The Max Planck Centres constitute a significant extension to the MPG's international cooperation efforts. The Max Planck Centres take collaborative science projects to a new level of quality with leading foreign partners in pioneering areas of research. Scientific cooperation programmes create platforms on which the participating Max Planck Institutes and their international partners can pool their knowledge, experience and expertise. Scientific value added is created through combining complementary methods and knowledge. The Max Planck Centres are expected to stimulate exchange of post-doctoral researchers to organise joint workshops and training activities, such as those within the framework of International Max Planck Research Schools

(IMPRS), to attract more scientists from other facilities as associated partners, to promote the joint use of research infrastructure, to apply for third-party funding for project-based collaboration, and ensure mutual access to their respective research facilities and equipment. The scope of the Centres' collaborative projects goes far beyond bilateral partnerships because larger international research projects enjoy greater visibility and are more attractive. There are currently 14 Max Planck Centres at ten locations worldwide.



4.2 Developing Germany's strength in innovation on the international stage

As a location for high-tech activities, innovation in Germany is essential to securing its competitiveness, future viability and its society's prosperity. The demand for knowledge, expertise and products from Germany is strong. Innovation is driven, not just by new technological developments, but also by new needs and challenges of a society. Digitalisation and globalisation provide important stimuli and strongly influence innovation processes. Innovations today increasingly emerge at the boundary between research and industry, at institutions of higher education and research institutes. In this context, it is very important to integrate the knowledge triangle.

The Federal Government's new High-Tech Strategy presents a comprehensive approach to innovation that satisfies these diverse requirements. The High-Tech Forum is currently working on suggestions for advancing the internationalisation of the High-Tech Strategy.

The Federal Government sees a need for interlinking German partners more closely with international stakeholders. Access to international innovation circles such as Silicon Valley must be made easier through new partnerships. The Federal Government also sees a need for action to boost international cooperation amongst research-intensive SMEs, where access to and use of international sources

of knowledge is becoming more and more important.

The Federal Government attaches great importance to the management and intelligent use of intellectual property. This applies equally to the setting of norms and standards in the international setting, which simplify access to existing markets and help to create new ones.

The Federal Government will also work to improve the general conditions to promote innovation. These must provide enough freedom and flexibility to guarantee the free flow of knowledge and innovation across borders and sectors. Through its dialogue with all stakeholders

Figure 9: Leading locations for innovation according to the European Innovation Scoreboard

Germany is among Europe's leading innovative locations

■ Innovation leaders

- Denmark
- Germany
- Finland
- Sweden
- Netherlands

■ Strong innovators

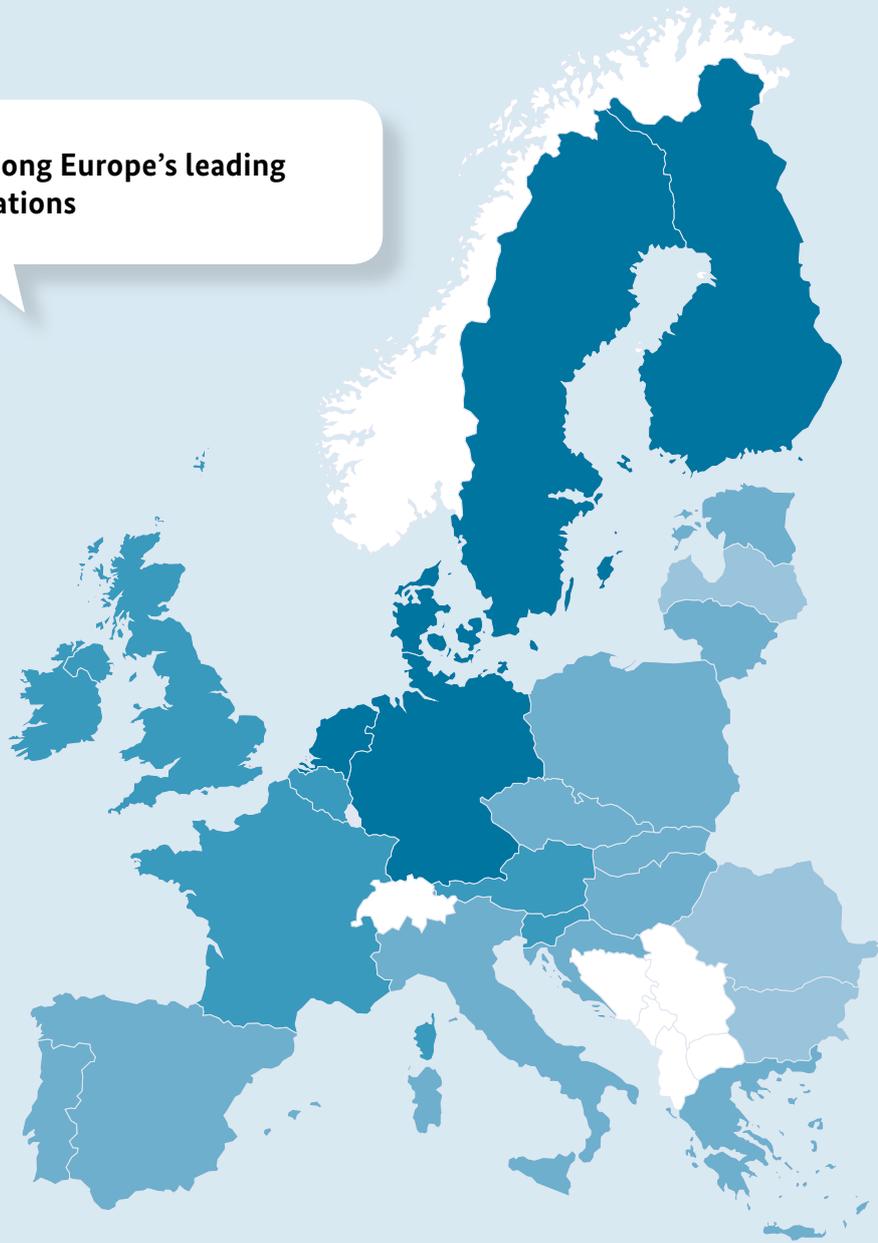
- Belgium
- France
- Ireland
- Austria
- Slovenia
- United Kingdom

■ Moderate innovators

- Estonia
- Greece
- Italy
- Croatia
- Lithuania
- Poland
- Portugal
- Slovakia
- Spain
- Czech Republic
- Hungary

■ Modest innovators

- Latvia
- Bulgaria
- Romania



Source: European Commission; European Innovation Scoreboard 2016

and social groups, the Federal Government will work to gain the necessary acceptance in those areas, which will have a great impact on society.

The Federal Government's Digital Agenda 2014-2017 comprehensively addresses the various aspects of digitalisation - from the roll-out of broadband and the digitalisation of the workplace, through to IT security. As important drivers of digitalisation, education,

science and research are an integral part of the Digital Agenda. The Federal Government's implementation of the Agenda will focus efforts on developing the European and international facets of these fields. Here again, the objective is to link national processes closely into European and international activities, and for this reason we want to step up research into digitalisation, its risks and opportunities.

German Research and Innovation Forum, Tokyo

It is important for German research stakeholders to be where innovation is happening. This is achieved through bodies such as the German Research and Innovation Forum in Tokyo. A good example is the annual presentation of the German Innovation Award (the Gottfried Wagner Prize) jointly with the Chamber of Commerce Abroad in Tokyo. The prize is awarded to young scientists working in Japan for outstanding work. The objective is to strengthen bilateral German-Japanese exchanges between science and business and to establish highly innovative research projects.



Compared to earlier EU framework programmes, Horizon 2020 places greater emphasis on support for innovation. In doing so, it makes an important contribution to creating a competitive Europe by paying more attention to the marketability and potential applications of the results of research. In addition, it fully grasps R&I to be part of an overall system.

Nevertheless, we should not forget that research remains the basis for innovation. This is why we must pay greater and more focused attention in future to the need for an effective balance at the European level in the support given to all the components of the innovation process. Within this context, joint research projects can form the bridge between basic research and application and should therefore not be excessively oriented toward applications. Support for innovation should rather be aimed at both the acquisition of fundamental insights and at commercial application, since innovations that make it to market can only be achieved in the medium term if the foundations are laid by research.



We will therefore ...

- **promote the internationalisation of the High-Tech Strategy tools**
- **support SMEs involved in international innovation collaborations**
- **support German stakeholders in internationalisation decision-making**
- **further develop innovation support at European level**
- **make greater use of European and international potential**
- **make use of new financing sources available at European level**
- **reinforce the role of education, research and innovation as drivers of the digitalisation process**
- **reinforce information infrastructures and ensure open access**
- **improve the commercialisation and management of intellectual property rights**
- **help to shape international norms and standards**

The BMBF's China Strategy

China has long been one of the world's most important research nations. Scientific and research collaboration between Germany and China has increased substantially in recent years, with over 1,100 collaborative projects currently underway between institutions of higher education. German scientific institutions are also cooperating closely with Chinese partners and have opened their own representations or institutes in China.

Cooperation between the two countries has intensified at the political level, particularly since the initiation of the Sino-German inter-governmental consultations in 2011. Since then, the BMBF has signed 19 Declarations of Intent with its partner ministry in the Chinese government, covering various research topics as well as cooperation in higher and vocational education. Federal Chancellor Merkel and President Xi Jinping spoke in Berlin in late March 2014 in favour of a "partnership in innovation for mutual benefit". This declaration was later fleshed out in the fourth round of Sino-German intergovernmental consultations in June 2016.

China is also the country in which the BMBF invests the third highest amount of funds for collaborative activities. Since 2002, BMBF funding for cooperation with China has tripled to reach an annual average of over EUR 20m in recent years. The cooperation has centred around innovation research, clean water

and/or environmental technologies, life sciences, marine and polar exploration, electric mobility, LED technologies, higher education and vocational training, and the exchange of students and scientists. On top of this, German scientific organisations and intermediary organisations spent some EUR 47m in 2014 on cooperation with China.



In October 2015, the BMBF introduced its China Strategy, which defines a systematic framework for cooperation with China in education, research, science and innovation for the 2015–2020 period.

Promote the internationalisation of the High-Tech Strategy tools

The Federal Government's new High-Tech Strategy from 2014 focuses more heavily on the aspect of internationalisation. It proposes that the integration of national, European and international innovation processes should be strengthened, along with the

integration of German stakeholders into global value chains.

- The BMBF supports cooperation by science and business in highly innovative regions of Germany with international partners under the Internationalisation of Leading-Edge Clusters, Forward-Looking Projects and Comparable Networks funding measure (*Internationalisierung von Spitzenclustern, Zukunftspro-*

Synergy project: National Platform on Electric Mobility

The Federal Government views the switch to electric mobility as a key challenge for mobility in the 21st century. Since it is highly relevant for industrial and employment policy, this subject is of great importance for our citizens, various sectors of industry and for Germany as a business location.

The Federal Government set up the National Platform on Electric Mobility (NPE) in 2010. The objective is to develop timely and pragmatic solutions and to efficiently combine cooperation between the departments on the subject of electric mobility - a topic of great importance for the future.



A total of EUR 223m was put up in 2015 as funding for electric mobility by four Federal Government ministries (BMBF, BMWi, BMVI and BMUB). The BMBF contributed the major share of the funding (EUR 83.3m).

In addition, Germany is working with China in the Sino-German Platform on Electric Mobility. The objective is to improve the exchange of information - especially on the matter of standardisation - and to discuss questions relating to electric mobility of relevance to both countries and to resolve them through bilateral projects.

jekten und vergleichbaren Netzwerken). In an initial round, 11 projects are receiving support. Another 11 clusters and networks are recommended for support in a second round, all of which include the involvement of SMEs. The topics range from bio-medicine, lightweight construction, organic electronics and electric mobility to "Sport of the Future". The third round of funding started in November 2016. We will raise the visibility of these networks at European and international levels.

- We are continuing to build on the successful participation of the leading-edge clusters in EU initiatives such as the KICs.

Support SMEs involved in international innovation collaborations

The Federal Government supports research-intensive SMEs in their efforts to make the best possible use of opportunities for European and international collaborative ventures. It also wants to further develop the potential for using German scientists working abroad to cover the demand for skilled labour in research-intensive SMEs in Germany.

- The BMBF has pooled its range of support measures in the SME International initiative (*KMU-International*). The focus is particularly on SMEs in the manufacturing industry with high levels of R&D activity. We will step up the information and advice provided to German SMEs on innovation cooperation at the European and international level, and also raise the international visibility of German systems expertise as part of the BMBF's Research Marketing Alliance.
- The BMBF will expand the 2+2 project approach at the bilateral level. These projects bring together academic and industrial partners from the partner countries in a consortium. German participation in these projects comes mainly from innovative SMEs. The focus is on application-related R&D projects in core technologies such as ICT, production and transport, and projects related to global change such as renewable energy, health research, biotechnology, food and agriculture, and environmental technologies.
- We will be further opening up BMBF national programmes to allow participation of international partners in joint collaborative projects. This will enable significantly more international cooperation on those topics defined as national priorities.
- Together with our European neighbours, we will be publishing new joint calls for proposals, targeted at SMEs, for projects in the field of sustainability research. Our objective is to drive forward the exchange of 'green' technologies jointly with SMEs, to step up the scientific advice available to SMEs, and to develop new forms of cooperation between scientific organisations and SMEs.
- The "Green Economy" implementation platform will support the export of new environmental technology from the funds available for research in developing and emerging countries. Particular emphasis will be placed on the joint development of "frugal technologies" locally with our partners.

The BMBF's international innovation cooperation in 2+2 format

The BMBF supports international R&D projects with partners from science and industry using the so-called '2+2' format. These projects involve the participation of one research institute or university and one company each from Germany and the partner country. The measures are financed bilaterally. The programme's objective is to access international sources of knowledge and application in order to strengthen German industry's potential for innovation through the joint exploitation of R&D results and technological market development. German SMEs gain access to international research networks, which can strengthen the profile of Germany as a location for innovation. 2+2 projects are currently underway with Turkey, Russia and India, with plans to expand the approach to other countries including as part of the 2nd Germany-Greece Research and Development Programme 2016.



Readily available facilities such as the BMBF climate centres in Africa can be used for this purpose.

- We will organise MINT recruitment campaigns for SMEs (MINT stands for Mathematics, Informatics, Natural sciences and Technology). The objective is to attract more German researchers working abroad to provide their skills for innovative SMEs in Germany. Among other measures, a dedicated MINT recruiting for SMEs platform (*MINT-Recruiting für den Mittelstand*) at the annual GAIN meetings can serve this purpose in future and build on the successes in bringing (and regaining) researchers to Germany.
- We will develop 'matchmaking' events in those destination countries most popular with German students abroad as a forum for attracting skilled workers to come and work for SMEs. These events will primarily be held in the study locations with the most German students. They will be organised in cooperation with the AA, together with the German Chambers of Commerce Abroad (AHK), and are aimed specifically at SMEs. BMBF will co-fund the programme.

- We are using the Central Innovation Programme for SMEs (ZIM) to boost SME participation in collaborative transnational research. The higher funding rate of up to 10% for companies' transnational R&D projects is intended to provide an incentive for international cooperation.

Support German stakeholders in internationalisation decision-making

The emergence of new centres of innovation and the highly volatile nature of new partners and competitors in the global world of innovation present stakeholders in research projects with huge challenges in their international activities. In this context, questions about future technological developments, opportunities for cooperation, the danger of loss of expertise and similar concerns are at the forefront.

- We will step up the provision of relevant information to support German companies in their decisions on collaboration and location. As part of this, an analysis of other countries' internationalisation strategies is planned.

- We see the provision of scientific advice to departmental research institutions on the regulatory aspects of innovative therapies and clinical studies as an important instrument that will reinforce the support for advice on international aspects (for example, the innovation office at the Paul Ehrlich Institute (PEI) or scientific advice from the Federal Institute for Drugs and Medical Devices (BfArM)).



Further develop innovation support at European level

In recent years, the EU has developed and introduced a whole range of tools for promoting innovation.

- We support a critical review and evolution of the current system with the aim of achieving better complementarity and networking. The cluster approach has proven itself in the area of innovation. The further development of the existing instruments in this area should also be pursued with the aim of increasing and simplifying SME participation.
- We favour a critical review of European Innovation Partnerships (EIP).
- We welcome the debate on the planned European Innovation Council (EIC). Its focus should be guided by added value for Europe and more “Excellence in Innovation”. If that condition is met, the EIC has the opportunity to become the flagship for the promotion of innovation in Europe. Possible measures could include refocusing of the SME instrument on high-potential SMEs, or greater and targeted use of ‘inducement prizes’ as an incentive to develop innovative solutions to major societal challenges. The EIC should also take over the function of ‘one-stop shop’ and guide through the European innovation support system in order to improve the clarity and adaptability of its instruments.
- We are investigating ways in which the EIT’s approach can be strengthened and developed. This could possibly also be developed into an ‘innovation label’ that could include further funding of innovation under Horizon 2020.

Make greater use of European and international potential

European and international collaborative projects open up a wider spectrum of cooperation with foreign companies for scientific stakeholders. In addition,

German companies – and SMEs in particular – can benefit from the stronger emphasis placed on innovation in the EU’s Horizon 2020 framework programme. German scientific and innovation stakeholders are participating in numerous European networks under the intergovernmental EUREKA programme.

- We will intensify our support in future for international, innovation-oriented collaborative projects between public sector R&D institutes and businesses. These will become a key component in the existing Scientific and Technical Cooperation (STC).
- We will coordinate national activities with European and international initiatives even more closely than in the past in order to exploit the potential to be found at all levels in the field of innovation, such as public-private partnerships.
- We will closely link the existing National Contact Points, both with each other and with national services, such as the Federal Government’s “Research and Innovation” Funding Advisory Service so as to provide an optimal advice service to the SME target group. SMEs will be provided with more information on innovation support measures in the market-oriented sector via facilities such as the “SME Instrument” and the “Fast Track to Innovation” programme. One focus of the advice will be possible EU follow-up financing for projects that were previously nationally funded. In addition, the relevant departmental research institutions offer early advice on regulatory questions as part of their statutory duties. The PEI’s Innovation Office and the scientific advice provided by the BfArM are examples of this.
- We will ensure that the cluster policy designed under EUREKA is further developed and linked in to national activities. Germany supports the work under EUREKA on the new “Global Stars” tool. This simplifies cooperation between SMEs in the countries participating in EUREKA and international partners from third countries. It enables various forms of innovation-oriented collaboration and focuses on the global outlook to which EUREKA aspires.

- We see the strengthening of Eurostars 2 (a measure under Art. 185 of the TFEU) as an important pillar of a common SME policy. The programme is run jointly as part of EUREKA by the European Commission and 34 states. The predecessor Eurostars 1 programme was successful at reaching its target group, with SMEs accounting for around 70% of participants. Since 2008, some 3,400 participants have been funded in over 1,000 projects under this programme. Participation of German partners in Eurostars projects is high and shows no sign of slowing. Some 350 participants are currently being funded in over 200 Eurostars projects in Germany alone. German participants most frequently collaborate with partners from France, Netherlands and Austria, followed by Great Britain, Sweden and Spain. Due in part to our positive experience with Eurostars 1, we will increase funding for Eurostars 2 and provide an average of EUR 15m annually (including the contribution from the European Commission) in support of the programme.

Make use of new funding sources available at European level

At national and European level, Germany continues to favour a broad mix of instruments ranging from subsidies via loans through to public participation. Funding of R&I through loans is an important foundation for improving Europe's competitiveness and capacity for innovation.

- New European-level R&I financing programmes offer new opportunities on top of traditional programmes. One example is the newly established European Fund for Strategic Investments (EFSI). This fund, in which the European Investment Bank (EIB) also participates, has assets of EUR 21bn. Its purpose is to finance risky projects in areas such as education, research, development and innovation. The KfW Group will provide an additional EUR 8bn for EFSI projects with a focus on German partners.
- We believe that the use of financing instruments under Horizon 2020 should be restricted to market-

oriented areas, such as industrial demonstration and market conversion projects. We will in addition ensure that financing through loans is not further expanded at the expense of grants-based R&I funding.

Reinforce the role of education, research and innovation as drivers of the digitalisation process

The Federal Government's national Digital Agenda (2014–2017) highlights the role of education, science and research as drivers of the digitalisation process and as a foundation for value creation in the market. Increasing digitalisation simplifies the creation of virtual research networks. These are often a meaningful supplement to, but no substitute for the funding of regional clusters, which are at the heart of a successful innovation policy at national and European level.

- In the science sector we will compile a "Strategy for Digital Transformation in Science and Research".
- We believe greater attention should be paid to funding opportunities for the digitalisation of research, including in the European structural policy.
- Digital education is a prerequisite, not only for meeting the requirements of work in the digital world, but also for ensuring societal and political participation. The Federal Government's efforts to promote good digital education will contribute to further increasing the international attractiveness of education, work and life in Germany. The Hochschulforum Digitalisierung (German Forum for Higher Education in the Digital Age), international cooperation in vocational education and training and the "Recognition in Germany" web portal make targeted use of the potential of digital education programmes for strengthening the international dimension of all sectors of education.

Synergy project: Industry 4.0 platform

Industry 4.0 integrates production processes with the most modern information and communication technologies. These technologies permanently change the way in which Germany produces and works. Using intelligent, digitally networked systems, people, machines, plant, logistics and products communicate and cooperate directly with each other. Industry 4.0 offers huge opportunities to Germany as a leading industrial supplier, with some 15m jobs in Germany depending directly or indirectly on the manufacturing industry. They contribute decisively to the strength of German industry's international competitiveness. To maintain and build on this strength, we want to tap the potential of Industry 4.0 at an early stage and play an active role in the transformation of industry to a digital base.

The Federal Government established the Industry 4.0 Platform with the objective of safeguarding and expanding Germany's leading position in the manufacturing industry. The Government wants to drive the impending structural shift and to create the uniform and reliable framework that it requires. The aspiration for the platform is to develop a uniform, global understanding of Industry 4.0 and to draw up recommendations for the action needed for a successful transition. In addition, examples of applications will be produced to show how the digitalisation of industrial production in companies can be successfully implemented.



The BMBF has so far approved funding of over EUR 120m for research into Industry 4.0. The BMWi is committing up to EUR 80m in research funding, concentrating in particular on standardisation and regulatory questions.

The challenges involved in implementing digital industrial processes are similar in many industrial areas across the world. International cooperation is of great importance for the development of technical solutions and for standardisation and regulatory issues. The Industry 4.0 Platform therefore also aims to drive international exchanges.

Reinforce information infrastructures and ensure open access

In 2014, the Federal and *Land* authorities set up the Council for Scientific Information Infrastructures. The objective of the Council is to improve coordination between the many activities underway in the field of scientific information infrastructures and to develop

evidence-based responses to the challenges associated with digital information infrastructures. The Council advises scientific and political bodies on questions relating to the further development of information infrastructures, such as long-term archiving, quality assurance of research data or the management of virtual research environments.

- We will actively support the work of the Council in the coming years. This work will include developments at European level. At the same time, the Federal Government will introduce ideas drawn from the national process into the European debate.
- The Open Access strategy submitted by the BMBF in 2016 is intended to improve the conditions for effective, long-term access to publicly funded research publications.

Improve the commercialisation and management of intellectual property rights

The transfer of knowledge and the management of intellectual property at German institutions of higher education and non-university research institutes in European (both on a bilateral basis and in the EU context) or international projects should be further strengthened by the application of ‘good practices’. One particular point of reference for this is the European IP Charter initiative for the management of intellectual property in the context of knowledge transfer activities.

- In addition to the regulation of subsequent exploitation rights, we will continue to develop a science-friendly copyright to simplify access to scientific information.
- We will also work at European level to ensure that the EU copyright framework is also adapted to the digital environment. Modern techniques such as text and data mining must be available to science, education and research. We will enable the production, management, use and transfer of data – even across state borders.

Help to shape international norms and standards

Markets are created and shaped by the setting of international norms and standards. To secure a strong market position for Germany, the involvement of German science and business representatives in the relevant international bodies is essential.

- We advocate promoting the worldwide harmonisation of norms and standards in order to remove technical barriers to trade. We support cooperation in the setting of norms with strategically important partner countries so as to open up new markets for German industry.
- We will work to ensure that German education standards are maintained and the German research funding system is adequately taken into account in bilateral trade agreements between the EU and third countries.

Scientific organisations in alliance – selected project

Personalised radiotherapy: the transatlantic alliance for optimal treatment of cancer patients (FhG)

Cancer is the second most common cause of death in Germany, claiming over 200,000 lives every year. Radiotherapy is applied in over half of all cases. The aim of the therapy is to kill off tumour cells while sparing the surrounding healthy tissue.

Led by the Fraunhofer Institute for Industrial Mathematics (ITWM) in Kaiserslautern, the DKFZ, Heidelberg University Hospital and Massachusetts General Hospital in Boston, USA, have been working on an alternative solution. Physicians, physicists, computer scientists and mathematicians have developed new software that reduces the planning time for the radiotherapy, makes it easier to strike a good balance between therapeutic effectiveness and possible side effects and ultimately improves the chances of a cure.

The software was tested in the radio-oncology clinic at Heidelberg University Hospital. The first clinical use of the Pareto optimisation was in 2011, with the support of the RaySearch Laboratories company at Massachusetts General Hospital in Boston. The American clinic is the oldest and largest teaching hospital of Harvard University's Medical School.

By the end of 2015, the system had been installed in some 400 planning stations in over 300 clinics. Following additional licensing by the US world market leader Varian Medical Systems, the technology will be available in over 20,000 therapy planning stations worldwide from 2016. The joint scheme covered projects financed by the public sector and projects financed by various

industrial donors. Donors included the BMBF, Stiftung Deutsche Krebshilfe e.V. (German Cancer Aid) and National Institutes of Health, USA.





4.3 Internationalising vocational training and qualification

The Federal Government sees a vital interest for the country in the internationalisation of vocational training. A high level of education – including in the non-academic labour force – strengthens the competitiveness of economies. It contributes to social peace, to protecting the country against economic crises and to combating the causes of displacement.

With its dual system of vocational education, Germany is held up as an example worldwide. Many countries are interested in collaborating with Germany in vocational training. They want to learn how dual mechanisms – such as the institutionalised interaction between the state and the private sector or the linking of in-company learning with vocational schools – function and can support competitiveness and the capacity for innovation.

Adequately trained skilled labour is also a precondition for the successful engagement of German companies in the target countries. Access to foreign markets for German services and products can only be achieved or improved if the professional skills for production, sales, consulting and maintenance can be found on the local labour market at the appropriate level.

The economic crises since 2008 have led to considerable upheavals on the labour market and to high levels of youth unemployment in some European countries. The Federal Government is working with its European partner countries on strengthening youth employment and modernising the vocational training systems. In this context, great importance is attached to increasing the mobility of trainees, especially using the existing instruments available in Erasmus+.

Collaborative activities with selected BRICS and OECD countries are focused on the provision of innovation consultancy to partner countries' vocational training systems. Adaptation of the legal framework in the country and the development of innovative framework curricula aligned to actual needs are the focus of these activities. Another important concern is to involve companies more strongly as a location for

learning and training and as a partner in the further development of vocational education. A key role is often played by German companies, since most are already undertaking training in the partner country using occupational models. The Federal Government supports German companies in training their skilled workers at their foreign sites. Looking forward, international cooperation in vocational training also forms a basis for attracting highly qualified workers from abroad. This will also play an important role in the reform of the EU's Blue Card system, which was initiated at EU level in the summer of 2016.

The Federal Government is also directing its efforts at increasing the mobility of trainees, simplifying the recognition of qualifications obtained abroad by foreign skilled workers, and extending the training of trainers to the international sphere. The following applies to all vocational training collaboration: there can be no simple 'as is' transfer of the German dual training system to a partner country. Instead, we assist the partner country to integrate elements of the German system into their own systems as necessary.

To meet the increased demand from abroad while simultaneously establishing a high quality level and

coherent approach among the German players, a number of important decisions on strategic direction have already been taken, based on the Federal Government's 2013 One-stop International Cooperation in Vocational Training strategy.



We will therefore ...

- **further increase the mobility of trainees**
- **expand cooperation in vocational training with relevant industrialised and emerging countries**
- **support the training of skilled workers by German stakeholders abroad**
- **develop a peer-learning platform for European countries**
- **simplify qualification recognition**
- **contribute to the shaping of international and European processes**
- **develop dual study courses**
- **fund international comparative studies in the field of education**



Further increase the mobility of trainees

The Federal Government has set itself the ambitious target for 2020 of enabling at least 10% of trainees in a student year to spend a period abroad during their training (confirmed by the Bundestag – see Drucksache 17/10986). This objective represented a significant increase on the European 2020 target, of at least 6% of a training student year spending a period abroad.

- We will, in particular, use the EU's Erasmus+ (2014–2020) education and training programme to meet our objective. We are aiming to further increase our rate of participation.

Figure 10: Number of participants from Germany accepted for Leonardo mobility measures (up to 2013) or Erasmus+ (from 2014)



Expand cooperation in vocational training with relevant industrialised and emerging countries

In response to increasing demand for well-trained skilled workers from industrialised and emerging countries, we will be expanding our cooperation with interested partners.

- We intend to implement core elements of the dual training system in joint 'beacon projects' in our partner countries as examples of our system. Thus, a programme for training staff was developed and tested in Portugal in cooperation with the Portuguese Ministry of Education and Employment. This programme is adapted to the situation in Portugal, which allows employees to receive up to 35 hours of further education per annum.
- We are assisting partner countries in training their trainers and in the development of education and examination regulations. One concrete measure is the establishment of vocational training and examination committees in which all relevant stakeholders participate. A further key element is the establishment and development of quality standards. In Slovakia, a new vocational training law came into force in April 2015 following consultancy provided by Germany. Starting in September 2015, the first classes in a four-year training course were able to have 60% of the training period spent with a company. The BIBB and the German-Slovak Chamber of Industry and Commerce Abroad together with Slovakian partners launched a pilot project in which 26 industrial and construction mechanics were trained in SMEs to obtain a double qualification (the *Abitur* university entrance qualification and a vocational qualification).
- In a second phase, we will be further developing the consultancy structures created by the AHK through the VETnet project in new locations (China, Greece, India, Italy, Latvia, Portugal, Russia, Slovakia and Thailand). We intend to convert these into a sustainable, self-supporting structure.

Vocational training with Mexico, India and the USA

In June 2015, the BMBF and the BMZ agreed a collaborative project in vocational education with their opposite numbers in Mexico. The objective of the project is to support Mexico in the further development of the Mexican system of dual vocational training (MMFD). The project will bring together the various stakeholders on the Mexican and German sides. The AA and the German-Mexican Chamber of Commerce and Industry (CAMEXA) are also involved. Many German companies are already providing dual training in Mexico. These activities are preparing the way for investments worth billions. Vocational training is also a key feature of the 2016-2017 Year of Germany in Mexico. A symposium on the dual training system was staged during the “Hecho en Alemania” industrial fair, bringing together representatives of business, associations and institutes at which dual vocational training was promoted to Mexican companies. In India, the BMBF and

BMZ are again taking this new, synergistic route with a joint declaration of intent on collaboration in vocational education.

Based on the AA’s Skills Initiative launched at its mission in Washington, the BMBF, BMWi and BMAS reached agreement in June 2015 with the three responsible departments of the US government (Department of Education, Department of Commerce and Department of Labor) on deeper collaboration in the field of vocational training. The German departments pooled their commitment in this important area to work together on this initiative. As in India and Mexico, the aim of the Federal Government’s action in the USA is to support German businesses locally in a practical way by helping to cover its need for skilled labour through creating or enhancing the provision of dual vocational education and training.

Vocational training partnerships in development cooperation

Since 2009, the BMZ has been funding vocational training partnerships with German business organisations in which chambers of commerce and business groups, together with their institutes, contribute their skills to vocational training development in countries with which Germany collaborates in economic development and, in the process, create direct transfer of knowledge. Local institutions and structures are to be strengthened, most particularly in Africa.



Vocational training project at the Audi Hungaria school

The AA is supporting a broad-based vocational training project attached to the Audi Hungaria Schule, a German School Abroad, in Győr, Hungary. The aim of its three subprojects is to produce 70 graduates annually from the dual vocational training course by the end of the project in 2020. The project is being run by the Audi Hungaria School Foundation (*Stiftung Audi Hungaria Schule*) and is being largely funded by the Audi Hungaria Motor company. In the medium term, the intention is to significantly increase the number of graduates and also to steer the training offered to trainees mainly outside the Audi plant in Győr.



Support the training of skilled workers by German stakeholders abroad

German companies with branches, subsidiaries and joint ventures abroad are a major driver of the training of skilled labour internationally. Well-trained skilled workers are one of the factors behind their high productivity levels and success in the local after-sales area.

- We will support the activities of German companies, and especially SMEs, in the training of skilled workers abroad.
- We offer German training providers support in creating consortia for international tenders and for operating models. Funding for German training providers is strongly oriented toward the strategic objectives of bilateral cooperation in vocational training.
- We are integrating German stakeholders in the dual training sector more tightly into international collaboration in vocation training. Experience has shown that success increases when the relevant stakeholders work directly with each other. For example, a German trade union is better able than a state body to convince its opposite numbers in Portugal of the advantages of dual training. For this reason, in addition to the Association of German Chambers of Commerce and Industry (DIHK), we will also be integrating the German Confederation of Skilled Crafts (ZDH) and the German Trade Union Confederation (DGB) more closely into our bilateral cooperation

Develop a peer-learning platform for European countries

There is great interest on the part of European countries in an exchange of experiences on the introduction of the dual training system, even extending beyond the BMBF's existing bilateral EU cooperation partnerships. Through multilateral exchange between vocational training experts, the BMBF's experience of bilateral collaborative projects can be made accessible to other EU Member States. This allows consultancy on the introduction of the dual system of vocational

training to be put on a broader base. This objective has already been agreed in the EU memorandum issued from the Berlin Ministerial Conference in 2012, although it has only been partially implemented by the European Commission.

- The BMBF supports the German Office for International Cooperation in Vocational Education and Training (GOVET) in building a European platform for a sustainable exchange of experiences at expert level.

Synergy project: German Office for International Cooperation in Vocational Education and Training

The “German Office for International Cooperation in Vocational Education and Training” (GOVET) was established in September 2013 and is located within the BIBB. The Office is a BMBF establishment to which the AA and BMZ contribute with seconding staff.

It supports international collaboration in vocational training by providing information and consultancy services to stakeholders, both inside and outside Germany. It also functions as the administrative office for the round table on international cooperation in vocational training. Representatives of the participating Federal ministries, institutes of the national vocational training system (especially the DIHK, ZDH, the Confederation of German Employers' Associations (BDA) and the DGB) together with the KMK also use the Office to coordinate their international collaborative activities in the field of vocational training. The Office provides support functions for the BMBF's bilateral vocational training

cooperation projects with a range of countries both inside and outside Europe. It provides expert knowledge, advises at system level and initiates pilot projects to develop and test elements of dual vocational training in the partner country.



Simplify qualification recognition

The recognition of foreign vocational qualification is an important instrument for immigration and for integrating skilled workers into the labour market, which may, however, only be temporary in the context of circular or rotating migration. The Recognition Act of 2012 accordingly allows immigrants and refugees holding foreign vocational qualifications to practise an equivalent profession in Germany and to integrate this way. The BMBF coordinates activities in this subject area on behalf of the Federal Government.



Interest in information and consultancy on the recognition of foreign vocational qualifications is growing constantly.

- Through our central information portal “Recognition in Germany” (www.erkennung-in-deutschland.de), we are promoting the opportunities to be found in the Recognition Act to an international audience. The portal is funded by the BMBF and can be accessed in nine languages. Through the “BQ-Portal”, the information portal for foreign professional and vocational qualifications, the BMWi supports the bodies responsible for the recognition of foreign vocational qualifications in their evaluation.
- It is also important to offer initial points of contact for on-the-spot consultancy outside Germany.

The BMBF is therefore supporting the DIHK pilot project Pro Recognition aimed at installing ‘recognition advisers’ in the AHK in selected countries. These contact and advice centres in the AHKs offer information on the recognition of professional qualifications in Germany, perform on-the-spot checks on the conditions for and utility of having the qualification recognised, and can help with submission of the application from outside Germany. This can lower the barrier to the immigration of skilled workers and minimise the time taken for their integration.

- We are continuing to expand recognition and advisory services on qualifications, together with updating training. We are making available funds from BMAS and ESF of around EUR 188m from 2015 to 2018 for the “Integration through Qualification” funding programme. With the assistance of the Federal Government, more employers will be targeted with information on the opportunities this recognition offers their company.
- Further measures include the list of shortage occupations drawn up by the BMAS together with the Federal Employment Agency and regularly revised in light of developments in the labour market, together with the “Make it in Germany” web portal, the skilled workers campaign launched by the BMAS, BMWi and the Federal Employment Agency.

Contribute to the shaping of international and European processes

The Federal Government wishes to encourage more people to make use of the wide range of vocational training opportunities on offer.

- We will ensure greater transparency of qualifications and skills and highlight cross-border commonalities more strongly. In this way, we seek to promote acceptance, accreditation and de facto recognition across national boundaries and thus to expand the European education area.

- We will both employ and shape European processes for cooperation in vocational education and training policy, such as the Copenhagen Process, with the aim of increasing the quality and attractiveness of vocational training – including across national borders. Together with our partners in Europe, we will further develop the European Alliance for Apprenticeships in order to improve transition into training and employment by implementing the principles of dual training in interested countries.
- Following Germany's initiative, the G7 countries committed at their summit meeting in Schloss Elmau in June 2015 to work within the framework of the Economic Empowerment of Women initiative to empower one-third more women and girls in developing countries by means of vocational training by 2030. This should improve their opportunities for employment and economic participation. The Federal Government is helping the countries with which it cooperates to design their vocational training and labour market policies in such a way as to enhance women's economic participation.

Develop dual study courses

Dual study courses make an important contribution to shaping the image of Germany as a location for higher education. They offer education that is simultaneously practical and science-based, often with an international element. The number of students following dual study courses in Germany has increased over ten years from just below 40,000 to over 64,000. Over this period, in addition to state and private-sector universities of applied sciences, there are colleges of advanced vocational studies (*Berufsakademien*), institutions of higher education offering dual study courses, and some universities. More and more companies are coming to appreciate this study model as a way of obtaining suitably qualified skilled workers.

- Along with the BDA and HRK, we endorse the expansion of the range of dual study courses currently on offer. We will support activities aimed at exchanging experiences and learning from each other at the international and European levels.

Fund international comparative studies in the field of education



Participation in international benchmarking studies offers the opportunity to gain insights into the skills acquired in the formal education system. The studies provide important insights into the strengths and weaknesses of the German education system. One focal point in these studies is school education – to which has been added in recent times the analysis of vocational education and training. Some of the most important benchmark studies carried out in recent years are the OECD's Programme for International Student Assessment (PISA) and Programme for the International Assessment of Adult Competencies (PIAAC), work-based learning in vocational education and training, along with the Progress in International Reading Literacy Study (PIRLS) and the Trends in International Mathematics and Science Study (TIMSS).

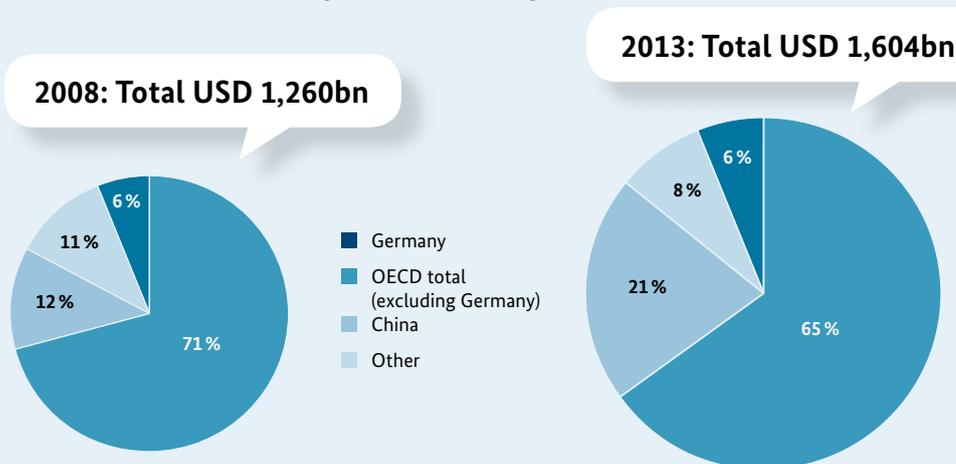
- In support of an evidence-based education policy and in agreement with the *Länder*, we will continue to ensure German participation in relevant international benchmark studies. We will use the ideas drawn from these studies for research into education.



4.4 Working with emerging and developing countries to shape the global knowledge-based society

An increasing number of countries outside the group of the industrialised countries are putting increased investment into developing their education and research systems. The influence of innovations driven by education and research on economic and social development – and consequently on stability and peace in the regions involved – is increasingly becoming the basis for governmental action.

Figure 11: Expenditure on research and development by world region (2008 and 2013 in absolute figures and percentages shares)



Source: OECD (for Germany, OECD total and China) UNESCO (for rest of world); figures for 2012 instead of 2013 for Botswana, Brazil, Guatemala, El Salvador, Malaysia, Mauritius, Paraguay, Qatar, Singapore, South Africa, Togo, Trinidad/Tobago, Tunisia and Uruguay

Digitalisation opens up further options for action and a new quality of cooperation with emerging scientific nations. Different stakeholders can be incorporated into the research process. Networking and exchanging knowledge become simpler and more dynamic.

With this development towards a scientifically excellent and digitally connected knowledge-based society, many emerging and developing countries will become partners in collaboration. The Federal Government wants to make use of this dynamic by integrating German science more strongly in these global processes.

Access to knowledge, researchers and partners, either physical or digital, should be enabled and facilitated. With respect to practical implementation, the task will be to improve networking, both within Germany and in the partner country, of existing collaborative

projects between German research and intermediary organisations, and partner countries. We want to contribute to developing common scientific practices and standards to jointly achieve a high level of quality across research cooperation. Mobility should be increased and common agendas set. With respect to matters of digitalisation, such as in the Open Access area, we also wish to develop a common understanding with emerging and developing countries.

When cooperating with these countries, scientific and political stakeholders often face challenges that cut across sectoral and geographical boundaries. Within this context, in addition to technological issues and development objectives, socio-economic aspects and system approaches are also important. For example, in many countries there is conflict between differing concepts on the use of agricultural land for biomass production. Sometimes the priority is on feeding the

The BMBF's Africa Strategy

The BMBF's Africa Strategy 2014-2018 places common research interests, education and scientific networking at the heart of Germany's cooperation with African countries. Central to this strategy is creating high-performance scientific hubs and research centres that take into account local and regional knowledge, and regional and national needs. The connection between research and its translation into practical applications, such as the creation of new products and services, should be reinforced. Emphasis is also placed on support for gifted young people, in particular in university post-graduate education and training. The objective is to make a significant contribution to the creation of a knowledge-based society, to strengthen regional and continental cooperation and tap into the potential for innovation.

The Africa Strategy offers a visible framework for guiding German and African stakeholders alike. The BMBF's



expenditure for Africa rose from around EUR 12m in 2005 to some EUR 58m in 2015.

population, and sometimes on producing biofuels or industrial raw materials. It is very important in this situation to achieve coherent synergy, not only between individual sector policies – such as health, agriculture or energy – but also between education and research policy and development and foreign policy. The Federal Government will ensure that any synergies that may emerge from improved coordination between Federal departments are exploited for joint initiatives. Moreover, global challenges cannot be overcome through the efforts of individual countries only: this calls for cooperation between the entire community of nations.



We will therefore ...

- **further develop existing cooperative projects and establish new partnerships**
- **systematically establish bilateral higher education structures**
- **exploit digitalisation opportunities in international cooperation**
- **make targeted use of European initiatives**
- **strengthen international structures for spreading uniform guidelines and principles**
- **jointly disseminate ‘good practices’ in scientific work**

Further develop existing collaborative projects and establish new partnerships

The Federal Government will build on proven tools and programmes for international cooperation, adapting these as required where conditions change. This can be done subsequently in various ways, including via joint or coordinated Federal department initiatives.

- We will support collaborative, structure-building projects between the research and scientific organisations concerned in cooperation with emerging

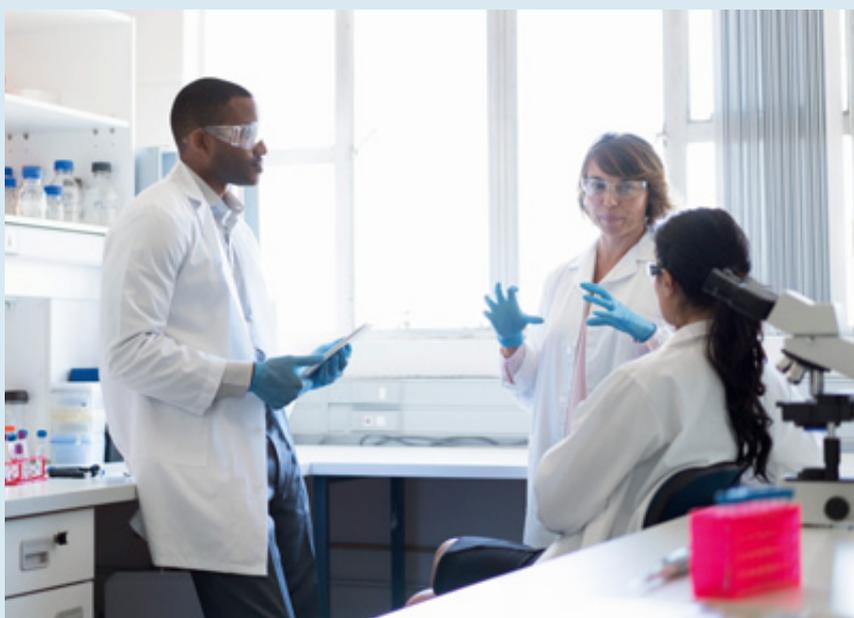
and developing countries. This will contribute to capability building in the partner countries where necessary.

- The Federal Government wishes to strengthen the role of research in providing policy advice. Social science and socio-economic research contribute to the understanding and solution of social transformation processes. This also includes scientific analysis of transregional and global interrelationships and exchange processes. Particularly against the background of social upheaval, crises and wars in many parts of the world, there is great need for scientific foundations and answers for new solutions.
- We will develop research centres in countries of both scientific and political importance in Asia, Latin America and Africa: the Maria Sibylla Merian International Centres for Advanced Studies in the Humanities and Social Sciences. The BMBF has developed this new instrument, based on the positive experiences with comparable formats in Germany (the Käthe Hamburger Kollegs). A linked objective is responding to increased demand for knowledge about prominent emerging countries and regions around the world, while also structurally reinforcing collaboration with these countries. The new centres are intended to act as focal points for ambitious research and productive intercultural dialogue between German and foreign humanities scholars and social scientists.
- Working through the Asia-European Meeting (ASEM), the Federal Government is committed to increasing mobility between these two regions of the world.

The Pan-African University

In 2009, the AU took the decision to found a Pan-African University (PAU) with five 'hubs', each focusing on a different subject area. The objective is to raise the quality of science and higher education in Africa and to find scientific solutions to global challenges locally. Germany has taken on the role of 'key thematic partner' for the PAU hub in Algeria (PAUWES), based at the University of Tlemcen. PAUWES is responsible for the themes of energy, water and climate change.

The BMZ and BMBF work together to support PAUWES. The BMBF directs its support at the development of the hub's research dimension.



Systematically establish bilateral higher education structures

The Federal Government will systematise its initiatives aimed at building up bilateral higher education facilities. These tools for cooperation with emerging and developing countries will be adapted to the respective country strategies.

- Based on experience to date, we will work with the countries to develop a modular range of tools for cooperation in the area of higher education, implementing them as necessary in cooperation with the various countries.
- We will develop and implement a broad range of instruments, including special mobility measures to boost student and scientist exchange in both directions; support for digital infrastructure and development (such as common applications and software); and the establishment of bilateral

higher education institutions, such as a German-Tunisian University.

- The topic "Research as a Driver for Digitalisation" will become a fixed part of the curriculum in bilateral higher education institutions.

Exploit digitalisation opportunities in international cooperation

The digitalisation of science offers particular opportunities for emerging scientific economies to collaborate faster and more efficiently with the world community. This potential must be exploited in particular to reduce the transaction costs of cooperation.

- In its initiatives with emerging and developing countries, the Federal Government will make greater use of the opportunities digitalisation

opens up for international cooperation. The emphasis here is on the possibility of developing new collaborative models for research and science, such as web-based contact exchanges to promote the mobility of scientists.

Make targeted use of European initiatives

The EU and its Member States are increasingly pooling their efforts when cooperating with emerging and developing countries. This is often more effective than initiatives launched by single countries.

- The Federal Government will further refine this additional level of cooperation and make greater use of it in future. In this context, we will improve



our coordination with other Member States and with stakeholders at EU level, such as the European umbrella organisations for research and scientific bodies. It is also important to integrate national and European initiatives more closely with each other.

- Applying the variable-geometry approach, the Federal Government will contribute to integrating where appropriate traditional bilateral collaboration with emerging and developing countries into

multilateral activities. Against this background, more use will be made of existing channels for dialogue at EU level, such as high-level dialogue with Africa and with countries in Latin America and the Caribbean. Our goal is to achieve greater coherence in international cooperation at EU level.

Strengthen international structures for spreading uniform guidelines and principles

Global associations of scientific organisations help spread and implement uniform guidelines and standards worldwide, of which the GRC and the International Council for Science (ICSU) are examples.

- The Federal Government intends to continue its support for such bodies in the future. They are an important foundation upon which to establish a global knowledge-based community.

Jointly disseminate ‘good practices’ in scientific work

The Federal Government believes that, in scientific work, quality-assured standards and their implementation are fundamental for collaborative research projects.

- The Federal Government will work with partner countries to support the dissemination of ‘good practices’ in scientific work worldwide.
- We will provide assistance to German research and intermediary organisations in their efforts to implement these standards worldwide. When applying scientific standards in collaborative ventures with emerging and developing countries, consideration must also be given to intrinsic and inherited knowledge.

Scientific organisations in alliance – selected projects

Centres of African excellence (DAAD)

Since 2008, the AA has been funding a total of eight centres of excellence in Africa through the DAAD. With their support, it is intended that high-performing teaching and research facilities will be developed at leading African higher education institutions. By providing sustainable structures, the centres enable future leaders in society and science to be trained in the African partner countries. In addition to the predominantly interdisciplinary academic training, all centres offer additional courses on subjects such as good governance, administration and German language and culture. The latest centre opened in Kenya in 2016 with the participation of German universities of applied sciences. The focus at this centre is on applied resource management.

In addition to all this, four centres of excellence in research and teaching have been opened since 2009 in Latin America and Asia: the German-Russian Interdisciplinary Science Centre, the South-East Asian Centre of Excellence for Public Policy and Good Governance, the Heidelberg Centre Latin America and the Centre of Excellence in Marine Sciences. German scientists and their partner institutions work in the four centres of excellence

with their foreign colleagues. They aim to achieve added value for all participating institutions as well as visible institutional effects for leading-edge research



and common development models for young people. Outstanding young scientists in particular in the partner countries are being linked to Germany at an early stage through joint research work, which also incorporates steps towards scientific qualifications.

Universities of applied sciences and transnational education (DAAD)

Transnational education (TNE) is a facet of the internationalisation of higher education, featuring the very visible engagement of German universities of applied sciences. This is evident in the DAAD's relevant funding programmes for transnational study courses: between 2010 and 2015, 52% of the funded projects were coordinated by universities of applied sciences. In no other area of DAAD funding are universities of applied sciences so strongly represented in terms of overall share of the student population in Germany.

In TNE, the requirements of the universities of applied sciences and the needs of the destination countries coincide particularly well. Internationalisation plays a part in competitive positioning for universities of applied sciences due to the boost it gives their profile and reputation. These universities also have a greater interest in well-qualified foreign students. TNE is also a particularly suitable instrument for recruiting junior staff. Involvement at the foreign site allows the early identification and local recruitment of gifted candidates

for further study in Germany, or of appropriately skilled workers for German employers.

The main target regions for TNE provision offered by the German universities of applied sciences are in emerging and developing countries. Economic development, technical progress and globalisation are leading to a constant rise in the number of countries and population groups participating in science as economic and technical progress raise the level of qualifications

demanding of employees. The practical nature of the study model offered by universities of applied sciences is of particular interest to them.

As a result of the success in implementing the “Made in Germany” approach of the universities of applied sciences in various partner countries, and the current demand for applied higher education, further major TNE projects of this type are planned in the Sub-Saharan region of Africa.

Developing the conditions for cooperation with Africa (DFG)

As part of their Africa strategy, the DFG is creating the conditions to enable scientists in Germany to work smoothly with their African partners. For example, some 25 consortia have been funded since 2007 as part of the infectious diseases initiative, and researchers from Germany work with colleagues from 16 African countries on

Mathematical Sciences (AIMS). The themes identified at the workshop are to be discussed in five African-German scientific workshops between now and 2018, to be held where possible at one of the five current AIMS centres (Ghana, Cameroon, Senegal, South Africa, Tanzania).

The collaborative ventures can be funded by the DFG, provided that they are successful in the normal DFG competitive process. This initiative complements AvH and DAAD measures that significantly strengthen the AIMS centres through endowed professorships and scholarships for students under the BMBF’s German Research Chair initiative.

In parallel with technical engagement, the DFG helps young funding organisations in Africa set up, develop their procedures and introduce funding standards, and tries to recruit them for the co-financing of projects. A one-week Science Africa event was held in Bonn in May 2016, attended by the chairs and coordinators of 14 partner organisations from Sub-Saharan Africa. Further contributions and support came from the AvH, BMBF, DAAD,

German Aerospace Centre (DLR), DZHW, KfW Group, Volkswagen Foundation, WGL, European Commission, France, Great Britain, Japan, Canada, Switzerland and the USA.

these projects, which run for up to eight years. The DFG has also been running a concentrated mathematics initiative since 2015. In March 2016 during the Next Einstein Forum in Dakar, Senegal, a theme selection workshop was held in conjunction with the African Institutes for



Funding the best in the “Continent of the Future”: Strengthening cooperation with AGNES in Sub-Saharan Africa (AvH)

The close links existing across national boundaries between AvH alumni in Sub-Saharan Africa offer many opportunities for the common shaping of knowledge-based societies. To tap into this potential the AvH, together with alumni from various countries in Sub-Saharan Africa and German researchers, founded the



“African-German Network of Excellence in Science“ (AGNES) in 2011. 20 countries in the region are currently members. The aim of AGNES is to strengthen science in Sub-Saharan Africa by creating a supra-regional structure, and to promote collaborative research projects between Africa and Germany. Particular attention is paid to supporting young talent at an early stage and young researchers from Sub-Saharan Africa can be nominated by AvH alumni for the AGNES Junior Research Grant. Between 2012 and 2015, 45 of these AGNES grants were awarded, with funding coming from the BMBF, the World Academy of Science and the AvH. Since 2015, seven recipients of these grants have successfully applied for a Georg Forster research scholarship. With funding from the BMBF, AGNES awarded the first of its AGNES Mobility Grants in 2016. These are intended to enable masters and doctoral students from Sub-Saharan Africa to spend a period of one to two months carrying out research at universities and research facilities in another country in the region.

Enabling trilateral cooperation: tapping the global creative force of the Humboldt network for development policy research (AvH)

Through its funding for institutional partnerships, the AvH supports collaborative research projects for up to three years between alumni from countries with weak currencies and German partners. Institutional partnerships have proved to be a very effective instrument for supporting the creation of long-term collaborative research projects involving young scientists. In many cases, institutional partnerships with alumni from emerging and developing countries make important contributions to solving global problems, such as the treatment of tropical diseases, increasing food security and quality or access to renewable energy sources. For this reason, the AvH endeavours to open up this type of

support for individuals to international, trilateral collaborative projects with a view to supporting research and knowledge-sharing in these and other highly relevant fields. This effect can be anticipated both from North-South-South institutional partnerships (Germany + two emerging or developing countries) and North-North-South partnerships (Germany + another technologically advanced country + one emerging or developing country).



4.5 Overcoming global challenges together

Global challenges such as climate change, health and food security do not stop at national borders. They can only be overcome through transnational efforts at the European and international level. Education and research create the knowledge required to develop solutions to global challenges and evidence-based policies.

The Sustainable Development Goals (SDGs) of the UN's 2030 Agenda for Sustainable Development play a key role in overcoming global challenges. This Agenda sets out global objectives for environmental, social and economic sustainability and the fight against poverty. These goals are to be achieved by 2030 and apply to all countries.

Education and research on global challenges call for an interdisciplinary and transdisciplinary approach, sufficient intercultural awareness and strong international networking.

In recent years, global steering mechanisms have been established in individual theme areas. These help to align politics, science and civil society. Some excellent examples are the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-

Policy Platform on Biodiversity and Ecosystem Services (IPBES). These intergovernmental committees assemble and evaluate current knowledge on global climate and biodiversity and, in so doing, provide the basis of knowledge needed by the political decision-makers.

International cooperation on global challenges has many benefits, ranging from sharing the risks involved in research and the pooling of resources (budgets and staff) to the global understanding of specific challenges. To leverage this effectively often requires that a number of practical challenges first be overcome. These include differences in funding structures and scientific standards through to unequal access to research results and asymmetric distribution of the benefits.

Fig. 12: Sustainable Development Goals



Source: UN

The Federal Government will step up its efforts to overcome the barriers to effective and efficient research into global challenges.

The BMBF's High-Tech Strategy already identifies global challenges as a priority area for its activities. Among other things, the strategy is an umbrella for the current framework programmes: Research for Sustainable Development (FONA³), Research for Civil Security 2012-2017 and the National Research Strategy BioEconomy 2030.

The meetings of the G7 science ministers and other bodies such as the Belmont Forum are global platforms that allow joint activities to be coordinated and implemented at international level. We can derive maximum benefit from these processes by aligning our resources and efforts at national and European level with them.

→ We will therefore ...

- strengthen the international networking of research into global challenges
- strengthen our commitment to overcoming the key global challenges
- put the G7 process on a sustainable footing
- integrate specific requirements of research into global challenges
- implement the Global Action Programme on Education for Sustainable Development
- strengthen policy advice on global challenges

International aspects of Research for Sustainable Development (FONA³)

Through its FONA³ framework programme, the BMBF will contribute to overcoming global challenges, such as climate change, food security, loss of biodiversity, soil degradation and raw material shortages, while at the same time safeguarding our standard of living. Research for Sustainable Development is developing innovative solutions to these challenges and providing the scientific basis for forward-looking action. The intention is for FONA³ to steer research projects, especially those in the City of the Future, Energiewende and Green Economy flagship initiatives, more firmly and in a more interdisciplinary way towards practical application. Stakeholders and user groups should be integrated into the selection of themes at an early stage and innovative solutions emerging from research should be supported right through to practical application.

Around EUR 2.1bn has been set aside for the five-year framework programme (2015-2019). International co-operation plays a key role here, past experience indicating that some 20% of project funding will come from international sources. Synergies between Horizon 2020 and FONA³ will be actively identified and exploited.



Strengthen the international networking of research into global challenges

In its commitment to overcoming global challenges, the Federal Government will place greater emphasis on bilateral networking with selected partners.

- In addition to funding actual collaborative projects, we want to improve the conditions for collaboration. The Federal Government must be mindful of the expansion of European initiatives and programmes to international level, especially in the case of multilateral initiatives.

- The Federal Government will make more intensive use of the Joint Programming Initiatives on global challenges for cooperation at European level, and we are in favour of extending the Joint Programming Initiatives to international partners. For example, Canada and Israel are already members of certain individual initiatives, for which they provide funding. The objective is to widen the circle of participating scientific regions by recruiting further strategically important third countries as partners in the JPIs. Australia, India, Turkey and the USA, among others, are already participating in proposal calls in 2016.

Table 1: Summary of Joint Programming Initiatives (JPIs) with German participation

<ul style="list-style-type: none"> • Neurodegenerative Disease Research (JPND) 	<ul style="list-style-type: none"> • Agriculture, Food Security and Climate Change (FACCE-JPI) 	<ul style="list-style-type: none"> • A Healthy Diet for a Healthy Life (JPI HDHL)
<ul style="list-style-type: none"> • The Microbial Challenge – An Emerging Threat to Human Health (JPI AMR) 	<ul style="list-style-type: none"> • Connecting Climate Knowledge for Europe (JPI Climate) 	<ul style="list-style-type: none"> • More Years, Better Lives – The Potential and Challenges of Demographic Change (JPI MYBL)
<ul style="list-style-type: none"> • Water Challenges for a Changing World (JPI Water) 	<ul style="list-style-type: none"> • Healthy and Productive Seas and Oceans (JPI Oceans) 	<ul style="list-style-type: none"> • Urban Europe – Global Urban Challenges – Joint European Solutions (JPI Urban Europe)

- We are striving to network European initiatives on global challenges with global platforms. Some initiatives are already in close contact with international stakeholders, such as the World Health Organisation and the Belmont Forum.
- Future BMBF funding programmes will, where reasonable and possible, be developed with a European component whose content will be aligned with the agreed JPI Strategic Research Agendas.
- At the same time, the Federal Government will work to ensure that the costs and benefits of these

initiatives and programmes are kept in reasonable balance, and the Federal Government will cooperate closely with the responsible international organisations.

Strengthen our commitment to overcoming the key global challenges

Societal change

Global challenges are found not only in the technical field or in natural or life sciences; subjects such as migration, crises and conflicts, or social participation and democratisation also touch on questions of societal change. To maintain social cohesion, we must discuss the aims, values and rules for living together.

- The BMBF's Cultural Diversity and Civil Society funding priority boosts research into societal

change. The four action areas, Social Crises and Upheavals, Participation and the Common Good, Migration and Integration, and Digitalisation of Society, are being addressed through new funding measures.

Climate

As a consequence of climate change, extreme weather phenomena such as heat waves, drought, floods and storms are becoming more common and increasing in intensity, making climate change and its many consequences one of the major global challenges. The world community has agreed the legally binding target of keeping the rise in the global average temperature to significantly below 2°C, compared to

The 'SONNE' research ship



Marine research provides important insights into climatic changes and ecosystems, but also into the use of marine raw materials. Multilateral cooperation is the rule in marine exploration. BMBF-funded marine research has been carried out for over 30 years in all the world's oceans and, during that time, virtually all of the SONNE research vessel's missions have involved international participation.

By commissioning the new SONNE vessel in December 2014, the BMBF has made a clear statement and continued the tradition. British colleagues had the opportunity to use the ship as early as its second voyage.

International cooperation among scientists on board German research vessels is supplemented by a wide range of bilateral projects. For example, a number of observers from the relevant coastal states have been invited to travel on board the vessels for set legs of a research mission. 'Open Ship' events have also been held during visits to various ports, involving lectures and workshops at local schools and universities. The research vessels also serve as an instrument of German diplomacy during joint events held locally with the relevant foreign mission.

The BMBF's long-term plans to replace the German research fleet (with the new SONNE, POLARSTERN and POSEIDON/ METEOR vessels) underline Germany's intention to continue to assume international responsibility for marine exploration.

pre-industrial values, and to make efforts to limit the rise in temperatures to 1.5°C above the pre-industrial level. Activities aimed at adapting to climate change are conducted on a cross-departmental basis in Germany.

- The BMBF is pursuing three objectives in its funding of activities related to climate change: to close gaps in our knowledge of climate change through high-quality research, to develop practical, effective expertise in applying climate knowledge, and to boost the innovative momentum for sustainable growth.
- Our efforts in climate research focus, in particular, on research into the consequences of climate change and how to adapt to them. The available resources are best utilised through bilateral programmes with countries such as those of West and Southern Africa and by participation in European and international initiatives to develop effective and sustainable solutions.
- Germany must furthermore be a reliable partner to countries having global importance due to their economic relevance, not just in climate policy terms but also as markets. This cooperation can also bring forth solid market prospects and opportunities for exporting innovative products and services.

Synergy project: SASSCAL and WASCAL climate initiatives

In collaboration with partners in ten countries from West Africa and five from Southern Africa, the BMBF in cooperation with the BMVI among others is developing two regional centres of excellence in climate change and sustainable land management in Southern and West Africa.

The objective of the two initiatives, SASSCAL (Southern African Science Service Centre for Climate Change and Adaptive Land Management) and WASCAL (West African Science Service Centre on Climate Change and Adapted Land Use), is to support the regions most seriously affected by climate change in Southern and West Africa by building scientific structures.

This is done in close cooperation with German higher education and research institutes and their networks. The centres of excellence are jointly financed by the partner countries to ensure long-term collaboration.



The BMBF is providing funding worth EUR 50m over a period of five years for each initiative. In July 2015, the WASCAL Ministerial Conference pledged to take on a larger share of the financing. There are in addition plans to open up the initiative to more countries in West Africa (Cape Verde, Guinea, Guinea-Bissau, Liberia, Sierra Leone).

Figure 13: Partner countries in the WASCAL and SASSCAL initiatives

Germany is developing regional centres of excellence, together with partners in Southern and West Africa



Source: BMBF

Synergy project: Cooperation in meteorological research

Extreme weather events and their consequences for life and limb require that research be accelerated and focused on improving the forecasting of such events. The severe damage caused by storms in Germany in June 2016 shows that there must be improvement in weather forecasting, on which decisions are based, especially at local level. To better forecast the damage and consequences resulting from such serious weather events, more accurate and detailed information from weather forecasts must be combined with the consequences and a better understanding of vulnerability. This major topic not only concerns extreme weather events and

their impacts in Germany, but also has high priority at international level and is being addressed in the WMO's High Impact Weather project. The project will run for ten years (2015-2024) and is financed both by national and by international funding from the participating countries and through contributions to the WMO Trust Fund (so far from Germany, Great Britain, Canada and Norway). Germany is supporting the WMO with a Junior Professional Officer.

- There are a number of bodies available for coordination of activities. At the global level, there is the Global Framework for Climate Services (GFCS), set up to improve the provision and use of climate information by appropriate climate services. At European level, there is the Connecting Climate Knowledge for Europe Joint Planning Initiative (JPI Climate). Cooperation with Africa is mainly supported through the SASSCAL and WASCAL initiatives (see the Synergy project: SASSCAL and WASCAL climate initiatives info box). Significant contributions are also made in support of the work of the Intergovernmental Panel on Climate Change.

Biodiversity

The loss of biodiversity and damage to ecosystems affects human well-being both directly and indirectly. The pressure on ecosystems and biodiversity is enormous. While this is particularly applicable in emerging and developing countries, it is also the case in Europe and other regions of the developed world. The major causes of this development include population growth, changes in consumption patterns and non-sustainable systems of land use. The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) is a platform that provides reliable and independent scientific bases for political decisions and helps to shape the international research agenda.

Synergy project: Bioeconomy/GlobE

Securing the global food supply is a central aim of the National Policy Strategy on Bioeconomy and the National Research Strategy Bioeconomy 2030. In 2013, in collaboration with the BMZ, the BMBF launched the “Securing the Global Food Supply – GlobE” funding initiative to support the development of sustainable and efficient agriculture worldwide. Up to EUR 45m is being invested in six research partnerships for a period of five years.

The funding initiative is facilitating a cross-disciplinary and systemic approach to research projects, which are tailored to local conditions and in each case considered by regional partners in Africa to be necessary and sustainable. The initiative is designed to be technology-neutral. It supports both existing networks and the creation of new partnerships in order to build new bridges between African countries and Germany, and between traditional cultivation techniques and highly-developed cultivation technologies.

The expertise that emerges from the research work will also be available to collaborative ventures with other regions of the world and thus serves as a model.



It is strengthened by international partnerships in R&D that look into problems relevant to the bioeconomy and have been funded by the BMBF since 2013 under the Bioeconomy International heading. Approximately EUR 30m has been set aside up to 2019 under three calls for proposals. A fourth call for proposals was announced in August 2016.

Synergy project: Green Innovation Centres and CGIAR

The Consultative Group on International Agriculture Research (CGIAR) was set up in 1971 in response to recurrent food crises and forecasts of future deterioration around the world. The Group now has 15 research centres on four continents and has been supported by consistent contributions from Germany since its foundation. The results of the applied agricultural research also flow into the networks of the Green Innovation Centres. Thus, through its One World – No Hunger special initiative, the BMZ is supporting innovations

based on needs and the partnership-based transfer of knowledge into the sectors of agriculture and nutrition of selected developing countries – with a regional emphasis on Sub-Saharan Africa. Numerous synergies with the SASSCAL and WASCAL initiatives funded by the BMBF emerge from this.

- We will be analysing the links between biological diversity and economic and social well-being in our research funding programmes. We will then build on that analysis to develop strategies and instruments on an interdisciplinary and participative basis intended to contribute to initiating sustainable economic development and farming (including 'green economy', land management and the fight against poverty).
- Germany makes a significant contribution to implementation of the EU Biodiversity Strategy and the work programme of the IPBES and the SDGs.

Urbanisation

Cities have a key role to play in the major challenges of the 21st century. These include mobility, the sustainable design of energy and water supplies, and quality of life and social cohesion. The eleventh of the SDGs is defined as "making cities and human settlements inclusive, safe, resilient and sustainable".

- The Federal Government supports this goal through the BMBF's flagship initiative "City of the Future" in emerging and developing countries. Under this initiative, we develop regionally adapted solutions that shape rapid growth in terms of supply infrastructures, mobility, and energy and resource efficiency. Local potential should be recognised and utilised in order to improve the quality of life and long-term prospects for all urban stakeholders. Building on the BMBF's "Future Megacities" priority topic (2005-2014), social, institutional and technical innovations should be jointly created with relevant institutions and representatives of civil society.
- The BMBF's flagship initiative can be linked into the New Urban Agenda adopted at the Third United Nations Conference on Housing and Sustainable Urban Development (Habitat III) in October 2016.

- In 2016, the Global Forum for Food and Agriculture (GFFA) addressed the question: “How to feed our cities? – Agriculture and rural areas in an era of urbanisation”. This Federal Ministry of Food and Agriculture (BMEL) initiative set the ball rolling at international level in the discussion about food security in urban areas. Agriculture ministers from 65 countries stated their intention to work towards close cooperation between cities, agriculture and rural areas with the aim of ensuring food security. The BMEL is bringing the results of the GFFA into play in international processes. (New Urban Agenda, G7, G20, etc.).
- In the interministerial task force on “sustainable urban development in national and international perspectives”, the Federal Government is also discussing questions of research and funding for implementing the SDGs in four working parties.

International collaborative research and projects on food security with the United Nations Food and Agriculture Organization

The funding initiative on international collaborative research for world food security by the BMEL is supporting the joint efforts of German research institutes with their counterparts in countries and regions seriously affected by starvation and malnutrition. The funding is focused on practical solutions that respond to real needs for improving food security, and on creating long-term viable partnerships between German agricultural and nutritional research institutes and similar bodies in selected emerging and developing countries. This focus should also not least contribute to further local capability development. An annual total of EUR 7m is available for this purpose.

The BMEL is additionally funding food security projects with the FAO through the Bilateral Trust Fund (BTF). 100 projects have been funded since 2002 at a total cost of EUR 121m. Through the BTF projects, the Federal Government is supporting the FAO in its remit to develop appropriate legal and institutional frameworks in the areas of nutrition and agriculture through political consultancy. The objective of the projects is to promote food security strategies, and their implementa-

tion, both nationally and between regions as well as in partner countries. Regional priorities are Sub-Saharan Africa and Afghanistan. Project priorities include: reducing malnutrition and nutritional deficiencies; agriculture and climate change; production of bioenergy/exploitation of bioeconomy and food security; implementation of the human right to adequate food and the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests (VGGT).



CLIENT II – International Partnerships for Sustainable Innovations



The emphasis in CLIENT II is on demand-oriented R&D collaboration. Higher education institutions, research establishments and companies headquartered in Germany work with international partners to jointly develop innovative technologies and application-driven services that meet real needs. With a strong emphasis on practical application, the concept also aims to take greater advantage of the economic opportunities for innovative 'Made in Germany' technologies emerging from R&D in selected emerging and developing countries. This is to be achieved through early stage strategic agreement with the partner countries and by focusing on particular topics and regions.

As part of the implementation of FONA³, the CLIENT II – International Partnerships for Sustainable Innovations programme is being further developed into an international approach that supports research collaboration on an equal footing and on the basis of mutual interest.

Priority topics are resource efficiency and sustainable resource technologies, climate protection/energy efficiency, adaptation to climate change, water and land management, energy systems and natural hazards.

Health

Societies all over the world are facing huge challenges in the area of health: providing appropriate care for an ageing population, the increased incidence of chronic diseases such as diabetes, drug-resistant pathogens and pandemics are topics that affect both industrialised and emerging and developing countries. The Federal Government supports R&I aimed at solving these problems, including as part of international measures.

- The public sector must increase funding for research into poverty-related diseases, both to compensate for the lack of interest shown by indus-

try and to respond to the growing need for sound research. The Federal Government will support bilateral activities with, for example, the countries of Sub-Saharan Africa, with a view to comprehensively strengthening biomedical research in Africa.

- Wherever possible, networking with European initiatives must be strengthened, primarily in this case with the European and Developing Countries Clinical Trials Partnership (EDCTP) under Art. 185 TFEU. In addition, the Federal Government will in future coordinate its activities closely with the G7 partners to create synergies and achieve sustainable improvements in the health situation in developing countries.

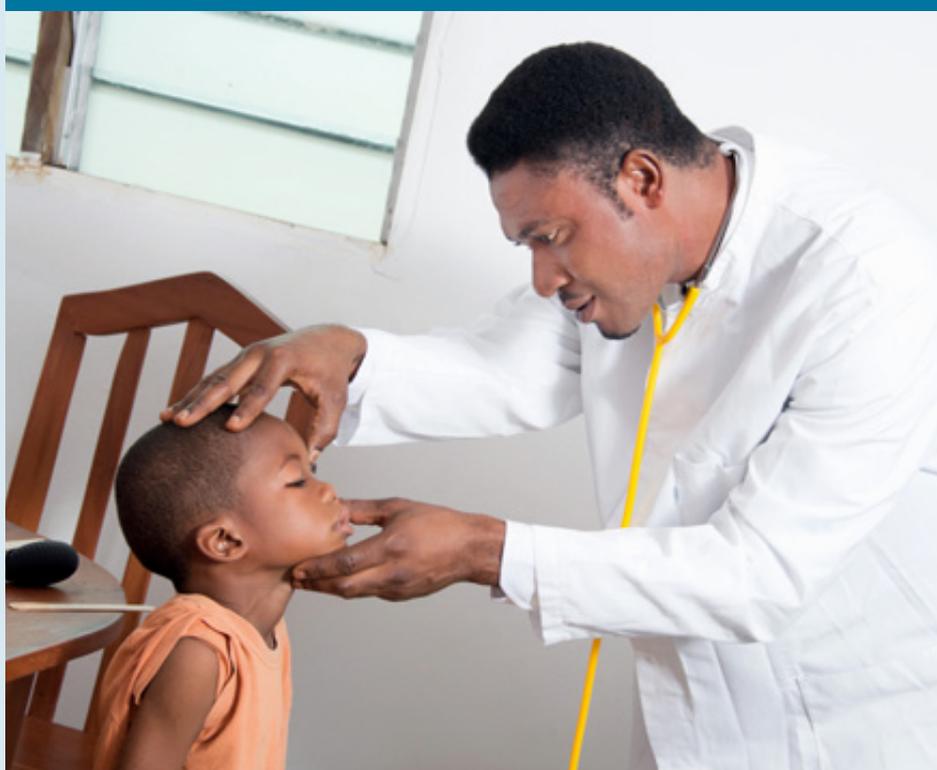
- We will step up research into global health problems as part of the Joint Programming Initiatives. The BMBF is a partner in all the health-related JPIs, such as the Neurodegenerative Disease Research (JPND) JPI. Under this JPI, we are jointly funding transnationally coordinated activities relating to research into neurodegenerative diseases. The BMBF is also a partner in the JPI on A Healthy Diet for a Healthy Life (HDHL) and the Antimicrobial Resistances (AMR) JPI. The HDHL JPI, for example, is looking into various factors, such as lifestyle and diet and their effect on health. The AMR JPI is trying to find solutions to the problem of increased incidence of drug-resistant pathogens.
- As part of the revised Global Health in the Focus of Research funding concept for neglected and poverty-related diseases, we will be launching a five-year round of funding for Product Development Partnerships (PDPs) in 2016.
- The working group which was agreed with the G7 partners met for the first time in October 2016 and will launch the research mapping for international research coordination and joint activities for poverty-related diseases.
- We will implement the research networks for health innovations in Sub-Saharan Africa.

European and Developing Countries Clinical Trials Partnership

The EDCTP was set up in 2003 as a European initiative aimed at overcoming the global health crisis. Among the partner countries involved, 14 are European Member States, two are Associated Countries and 48 are countries in Sub-Saharan Africa.

In 2014, the European Parliament and the European Council decided to continue the programme as EDCTP 2 under the umbrella of Horizon 2020. The objective is to develop diagnoses, medicines and vaccines to combat the three major poverty-related diseases – HIV/AIDS, malaria and tuberculosis – as well as other neglected infectious diseases. Against the background of the successes achieved in the predecessor project, Germany decided to also participate in the successor programme.

The EU is making up to EUR 683m available for EDCTP 2 from the budget for the “Health, demographic change and well-being” societal challenge.



The states participating in EDCTP 2 do so at the same level. A total budget of up to EUR 1.37bn is available for the period 2014 to 2020

Research Networks for Health Innovations in Sub-Saharan Africa

The BMBF has been providing increased support for health research in the countries of Sub-Saharan Africa since 2014 through the Research Networks for Health Innovations. The initiative supports both collabora-

tion between German medical research institutes and African universities, and African research institutes networking with each other. All the networks are co-ordinated locally by African scientists, building on already available structures and resources and thus making use of synergies. The research networks work closely with universities and care facilities, and so sustainably reinforce the education and health systems in the African partners.

Five African-German research networks were selected in the summer of 2015 from over 70 applications and have already begun their work. The BMBF is providing approximately EUR 50m for the networks up to 2020. The research networks are a part of the BMBF's Africa Strategy.



Put the G7 process on a sustainable footing

The G7 countries play an important role in research into global challenges, such as health, food security, climate, environment and energy, and are responsible for a large part of public sector research tasks globally. The fight against neglected and poverty-related diseases, the future of the seas and oceans, global research infrastructures and clean energy were at the centre of discussions between G7 science ministers at their meeting in 2015.

- The Federal Government views joint commitment to research cooperation in these areas as an im-

portant political signal and will work to ensure the implementation of joint activities.

- Essentially, public funding for research on these topics should be put on a comprehensive and ongoing footing. The results of the research will be shared among significant stakeholders.
- We will implement the decisions on bilateral and multilateral initiatives, workshops and measures in agreement with our European partners and ensure their sustainability. Synergies will thus be created with further international processes and forums.

Synergy project: Joint collaboration in G7

The G7 countries have agreed on greater cooperation on matters such as health, energy and the future of the seas and oceans. Interdepartmental cooperation was particularly intense in the period leading up to, during and following the German presidency in 2015. This may also result in interministerial initiatives and the renewal of research agreements in the future.

Health

G7 vision for global health: contribution to the Improvement of International Health

Functioning and resilient health systems are the key to being able to quickly recognise and combat health crises, and local healthcare must be strengthened accordingly. The RKI, PEI, BfArM and the Bernhard Nocht Institute for Tropical Medicine (BNITM) have launched a programme to implement the G7 decisions. The objective of the programme is to strengthen health systems, primarily in Africa but also in Asia and South-Eastern Europe. Around EUR 20m has been set aside between 2016 and 2020 to deliver the G7 vision.

Through translational research we want to go beyond 'lab bench to bedside' (that is to say, from laboratory to clinical application) and build bridges to clinical practice. The application of, and access to, scientific insight in everyday clinical practice should be supported internationally. Standards of treatments should also be improved internationally and brought to an equally high level.

Antibiotic resistance

The G7 countries support the One Health approach to combating resistance to antibiotics. This approach embraces all areas of human and animal health including agriculture and environment, and will form the basis for the formulation or revision of national action plans. In addition to measures being taken in the G7 states themselves, they are also assisting other countries in implementing the One Health approach. For Germany, the departmental research institutions – in particular the Friedrich Loeffler Institute (FLI), the Federal Institute for Risk Assessment (BfR), RKI, PEI and BfArM – will contribute to developing the process. They will additionally work with others to resolve existing problems, both through their own research and through their contacts with international health organisations.



Infectious diseases

Some two-thirds of all infectious diseases are so-called zoonoses. These are infectious diseases, caused by pathogens, which can be passed between both animals and humans.

A research agreement concluded in 2006 between the BMBF, BMEL and the Federal Ministry of Health (BMG) was renewed in 2016 and extended to include the Federal Ministry of Defence (BMVg). Existing initiatives already successfully established, such as the National Research Platform for Zoonoses, are being further developed and, as before, will be substantively managed on a cross-departmental basis. New research activities are also to be initiated.



In the area of human and animal health, Germany's departmental research institutions make a significant contribution to the fight against global infectious diseases. Based on experience gained during the Ebola epidemic, they are working with international bodies including the World Health Organisation, the European Medicines Agency and the US Food and Drug Administration. The goal is to develop rapidly adaptable emergency measures and treatments, to generate science-based criteria for their application, to implement the International Health Regulations for combating such epidemics and to help in building appropriate structures in developing countries.

Energy

The G7 states wish to contribute to achieving a long-term low-carbon world economy through the development and implementation of innovative technologies, aiming to transform the energy industry by 2050. The G7 science ministers have confirmed their desire to contribute to this transformation. They agreed that research efforts must be stepped up in order to accelerate technological progress towards clean energies and so make technological solutions available to society as quickly as possible. They are aiming for increased transparency and better coordination of their own energy research programmes. Technological progress cannot, however, be achieved in isolation from society. For it to succeed, citizens must give their support to the technological progress that accompanies the transformation of the energy system. For this reason, the G7 science ministers want questions of societal acceptance and implementation to be better addressed in the research.

The future of seas and oceans

Marine litter

The G7 states have committed themselves to an action plan to combat marine litter. The plan covers in particular measures to combat the deposition of plastic waste at sea or from land, as well as waste removal. The need in this area for education, research and outreach to other countries and stakeholders is also underlined. The science ministers have decided to implement joint research initiatives to combat increasing plastic waste in the oceans. The G7 countries agree that increased research cooperation is needed in order to protect the oceans.

Further international scientific collaboration

The G7 countries are united in their desire for a more accurate prediction of future changes in the seas and oceans and their effect on the environment and mankind in order to better manage and mitigate their impact. At their 2016 meeting in Japan, the G7 science ministers agreed to step up monitoring of seas and oceans worldwide. Especially important measures in this context include ensuring long-term financing of the monitoring infrastructure and quality assurance of the data.

Deep-sea mining

Following decisions taken at Schloss Elmau, the G7 science ministers devoted themselves to the question of research into the ecological impact of deep-sea mining. They encouraged research into deep-sea ecosystems



and the possible effects of marine mining on these systems.

Integrate specific requirements of research into global challenges

Global challenges involve different disciplines, social areas and stakeholders. As a rule, it requires equal consideration of issues related to the economy, demography, biospheres, etc.

Research into global challenges is currently often strongly compartmentalised into individual disciplines. The potential to unify different research areas, translate research results into practice and thus also make possible potential holistic solutions is not yet being fully exploited at either national or international level.

- The Federal Government will support work by research institutions and organisations that aim to integrate the specific inter- and transdisciplinary requirements of research into global challenges into the scientific system in a way that is geared to

solutions and based on actual needs. Public health institutions are important in the translation of research results into health care measures as they possess relevant and reliable data on disease burden and are in a position to translate insights into risks to health, and new preventative approaches into practical measures. Their experience is to be brought into the development of health systems, as shown for example by G7 collaboration.

Implement the Global Action Programme on Education for Sustainable Development

The five-year Global Action Programme (GAP) on Education for Sustainable Development (ESD) (2015-2019) follows on from the successful UN Decade (2005-2014). The Federal Government views the GAP and its implementation at national level as an important contribution to achieving the SDGs.

- As the lead department, the BMBF will have a decisive role in helping to shape the GAP. The National Education for Sustainable Development platform brings together senior decision-makers from politics, science, industry and civil society. They will adopt a national action plan for implementing the GAP and draw greater attention to ESD, both nationally and internationally. Our objective is to develop ESD 'from project to structure', by which we mean to embed ESD structurally into all areas of education and to link formal and informal education sectors worldwide. The BMBF is one of the key stakeholders exchanging examples of best practice in a new UNESCO international network.
- We will integrate the goals of ESD into a wide range of programmes and projects: the FONA³ framework programme, international exchange programmes as well as programmes and pilot projects on vocational training for sustainable development.
- The Federal Government continues to support the activities of UNEVOC (International Centre for Technical and Vocational Education and Training), UNESCO's vocational training centre. UNEVOC is the lead organisation responsible for introducing vocational training aspects into the future shaping of ESD-related activities and shapes the training aspects of the Post-2015 Agenda. Through vocational training, we want to contribute to aligning economic growth with provision of livelihoods (Greening TVET).

Strengthen policy advice on global challenges

Overcoming global challenges, such as climate change or increasing antibiotic resistance, requires measures coordinated at international level. Forums such as the IPCC or the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) develop science-based options for decisions on coping with climate change or loss of biodiversity.

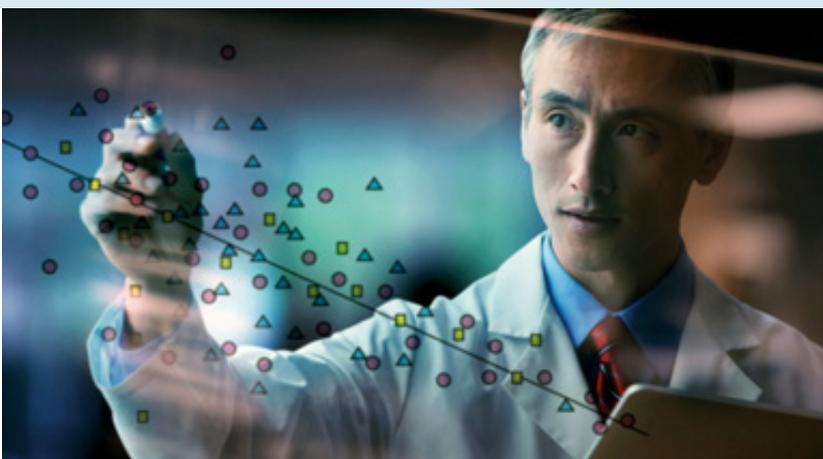
Departmental research institutions play a key role in this process as international stakeholders and advisers to science, politics and society.

- The Federal Government will support the work of German researchers in these bodies. The particular task here is to provide emerging and developing countries with science-based options for decisions.
- The Federal Government will continue to support socio-ecological and socio-economic research into global challenges in order to strengthen the potential for specific policy advice, including in partner countries.
- The Federal Government will exploit and support the capability of the departmental research institutions.
- The Federal Government will support international research cooperation, taking into account internationally active establishments and organisations to further develop the potential for providing targeted political advice.

Alliance of Science Organisations – selected projects

Science 2.0 – representing interests at European level (WGL)

The transdisciplinary Leibniz Research Alliance Science 2.0 comprises 37 infrastructure service providers and



research institutes. They address the question of how the ‘participatory web’ with its new forms of communication and collaboration impacts upon science, society, and the research and publication processes. The research priorities are ‘New Working Habits’, ‘Technology Developments’ and ‘User Behaviour Research’. The overarching goal of the Leibniz Research Alliance is to establish Science 2.0 as a new and transdisciplinary research discipline in the scientific community. To this end, the alliance is at the present stage advising national and international political decision-makers and research funding bodies on defining and establishing research funding programmes on Science 2.0 and Open Science, as well as on related topics.

Leibniz Center Infection – research and application for the benefit of world health (WGL)

The Leibniz Center Infection (LCI) brings together a number of Leibniz institutes: the BNITM, the Research Centre Borstel – Leibniz-Centre for Medicine and Biosciences (FZB) and the Heinrich Pette Institute – Leibniz Institute for Experimental Virology (HPI). Together they constitute a unique centre of excellence in research and education on infectious diseases. Their contributions to research and the fight against poverty-related and neglected diseases, such as tuberculosis, malaria and Ebola, are aimed at overcoming these global challenges through collaboration, in this case primarily with international partners from Africa and Eastern Europe.

With the assistance of the Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR) in Ghana or the European Mobile Laboratories (EMLabs), which the BNITM has developed together with partners from Germany and Europe, the LCI partners also apply their research in areas particularly impacted by infectious diseases. Scientific and medical staff is trained on the

mobile laboratories so that they can set up the laboratories independently. In addition, the Leibniz Graduate School “Infections”, established within the framework of the LCI, offers international postgraduate students an interdisciplinary training and research programme in infectious disease.







5 Research and academic relations policy and international networking



5.1 Research and academic relations policy

In the light of the internationalisation of education, science and research, academic relations policy has developed into a cornerstone of Germany's cultural relations and education policy. Support for education, science and research is key to increasing integration into worldwide flows of knowledge and this must include the long-term maintenance of contacts with networks of alumni in both academic and science circles. The objective of the support is to allow coherent education biographies to be created, for example starting with German Schools Abroad, passing via a DAAD scholarship ideally through to a brilliant career in science, supported by the AvH. Exchange with businesses and stakeholders in application-oriented research also forms part of this focus.

International cooperation involving joint learning, research and teaching will increasingly become the normal way of working. To increase the coherence and effectiveness of the various instruments and measures within research and academic relations policy, the AA has merged the responsibilities for education, science and research, previously vested in different departments, and brought them together under the heading of cultural relations and education policy.

Scientific exchange also has an effect in the pre-political sphere, even with difficult partners. The training of future elites in partner countries can create durable relationships and promote interest in scientific endeavour in Germany. Transnational scientific collaboration is the precondition for global

value chains. It fosters economic, social and societal innovation and provides the platform for finding answers to the major transnational challenges, such as climate change and food security.

The conditions for a common sense of responsibility and shared knowledge and ideals must be created first so that Germany can continue to contribute in these areas while surviving in the face of international competition. Education, creativity and expertise can be found worldwide. To exploit and bring them together, Germany must strengthen its position as a location for science and business through support for international cooperation and mobility. We must start talking to potential partners worldwide and create real, and not merely virtual, spaces in which we can

act together. The foundation for this is the targeted provision of information about Germany and the presentation of Germany as a location for science, research and innovation.

Following the launch of the Research and Academic Relations Initiative 2009, the AA, together with the

BMBF, initiated the establishment of the German Research and Innovation Houses (DWIH). Located in New York, Tokyo, Delhi, São Paulo and Moscow, they present Germany as a location for science and research, combining the interests and stakeholders of all the German scientific and research organisations. In their country and region, the DWIH contribute

DWIH New York

The DWIH New York has established itself as representative and advocate of the German science and innovation landscape in North America. It achieves this through outstanding events such as the ‘Healthcare Innovation World Cup’, which the DWIH runs in conjunction with Boehringer Ingelheim and others, workshops on nanotechnology together with the MPG and US research institutes, or symposiums on subjects such as “Skills Training for a Modern Manufacturing Workforce: Does the German Model Have Lessons for the United States”, which it runs in conjunction with the US Secretary of Commerce, Siemens and others.

The DWIH enhances transatlantic cooperation by bringing together stakeholders from the natural sciences, technology, industry and the humanities. It offers a platform for presenting excellent R&I in a rapidly changing world, thus providing interested parties in North America with the best access point to the German research and innovation landscape.

Important representatives of both public and private sectors are brought together on a diverse range of cutting-edge research topics. Experts meet up to find common solutions to global problems ranging from smart grid technology, via big data,

cybersecurity and cancer research through to global logistics and the promotion of MINT subjects.

In reaching out to the public and by building and supporting networks, the DWIH acts as an ideal starting point for international research collaboration. The DWIH’s support enabled cooperation between German and US universities in new areas of research to get off the ground, one example being the collaboration between Ludwig-Maximilians-Universität Munich and the University of Rochester in sports medicine. The initiation of collaboration between companies and universities, such as between SAP and New York University on supporting start-ups, is also part of the practical work of the DWIH.



significantly to enhancing the visibility of German innovators and to raising awareness of the science, research and innovation landscape. They achieve this through their wide-ranging activities and local co-operation with business and scientific organisations, for example through offering prizes. Scientists can also obtain effective, focused and personalised advice

German foreign missions take on a central role as gateways to the science location. Their analyses and reports on developments in technology and research policy in their respective host countries and their practical support for bilateral cooperation relationships, supporting experts from Germany and looking after German scientists abroad, and their work to

maintain contact with important stakeholders in the host country, lay a broad base for scientific and technological cooperation. This network of science counsellors is important for research and academic relations policy and should be built upon to benefit Germany as a base for innovation.

Experts from German scientific organisations also support the work of the foreign missions. A corresponding agreement between the AA and the WGL on study visits has been in place since 2012. For the foreign mission, these expert visits, which last for several months, offer the opportunity to expand their expertise in selected and complex subject areas. The WGL's objective

as part of the Internationalisation Strategy is to give colleagues the opportunity to gain professional experience abroad and make contacts that may benefit the work of the Community. Visits have to date been arranged in the USA, Brazil, China and India as well as to locations of UN organisations.

Research and academic relations policy facilitates long-term and durable international scientific networks. There are many alumni, experts and friends of Germany around the world today who play their part in how Germany is perceived. This exchange of experience and knowledge is at the heart of scientific collaboration.

At the same time, a key concern of the Federal Government is to create scientific and academic perspectives at times of crisis and in conflict regions. This applies equally to young people working towards a university degree and to fully trained scientists.



here so as to expand collaborative activities between partners from Germany and the target region, and to prepare the way for fresh collaboration.

The DWIH reinforce research collaboration with the best in the world and tap the potential for innovation through international cooperation. They put on the widest range of events, many of which have become fixed venues for potential partners in the host countries and include science lectures, events on innovation topics, the Russian-German Young Scientist Week or the German Innovation Award. We will further develop the concept of the DWIH in coordination with the German research and intermediary organisations.

Our research and academic relations policy is based on the systematic promotion of international networks in the fields of higher education, science and research to create innovation-friendly conditions. Promotion of structures and support for scientists goes hand-in-hand here; and in this context, the

The Federal Foreign Office's package of measures on displacement and migration

At international level, Germany has taken up a leading role with its commitment to providing higher education for refugees. A particular focus is on Syria, which is in danger of losing an entire generation of academics and future experts and leaders due to the conflict. To counter this danger, the Federal Foreign Office (AA) set up the forward-looking Leadership for Syria special scholarship programme in September 2014. 200 scholarships are on offer for students from Syria who would like to follow a course of study at Bachelor, Masters or PhD level. The recipients of these scholarships are selected on purely technical criteria. While some have previously lived in Germany, most come from Syria or neighbouring countries. Following a preparatory German course in Marburg, the young students started their studies at 60 universities spread across the whole of Germany in the 2015 winter semester. All holders of the scholarships also take part in a supporting programme, which teaches the skills and competencies required for future leadership tasks.

The AA established the Albert Einstein German Academic Refugee Initiative (DAFI) within the UN High Commission for Refugees (UNHCR) in Geneva in 1992. DAFI is a third-country scholarship programme that allows recognised refugees to study at a university, a university of applied sciences or an equivalent institution. Each year, some 2,200 young people from 42 countries study in this way on courses lasting on average three to four years. Since its foundation, DAFI has enabled more than 7,000 refugees to follow a course of higher education. In 2014, DAFI significantly expanded its programmes in the Middle East as the

crisis in Syria led to a dramatic increase in the numbers of refugees in that region. As a result, over 300 Syrian refugees were being supported in the main host countries in 2015, compared to 33 in 2013. Estimates state that at least 64,000 Syrian refugees in neighbouring countries and 29,000 in Syria itself would like to start studying or resume their interrupted studies.

The AA significantly expanded its DAFI programme in 2016 by making 1,700 additional scholarships available for Syrian refugees in Turkey and countries neighbour-



ing Syria. Also, 300 refugees from Afghanistan and 560 from Sub-Saharan Africa have the opportunity to study at universities in their host countries.

Expansion of the DAFI programme is thus just one element in a package of measures being implemented by the AA with the help of the Displacement and Migration extra-budgetary funds. Further scholarship programmes are being implemented with the support of the DAAD

in selected transnational education projects run by German institutions of higher education in the countries bordering Syria. A particular focus here is on the Turkish-German University, the German-Jordanian University, the German University in Cairo and the campus

the future rebuilding of Syria's historic cultural heritage. The priority in this package is to give further training to Syrian architects, archaeologists, heritage conservationists, construction history specialists and, above all, craftsmen in Syria's neighbouring countries.

In addition, 60 scholarships are awarded to young Syrian graduates who wish to start studying for a Master's degree in the conservation of monuments, either at Cairo's Helwan University or at the German-Jordanian University in Amman.

A programme will be launched to train and educate local skilled workers, who will be able to practise what they learn maintaining important monuments in Lebanon, Jordan, Iraq and Turkey. The project is being carried out mainly by the Archaeological Heritage Network (ArcHerNet), which was set up in 2015 and brings together various German bodies and universities from the fields of cultural heritage preservation and conservation of monuments. At international level, the network is working with UNESCO and the Iraqi and Syrian antiquities authorities.



of the TU Berlin in El Gouna. A total of 160 scholarships are awarded. In this way, the commitment abroad of German universities and universities of applied sciences, which have worked with partner institutions in the MENA (Middle East and North Africa) region to develop binational anchor universities, is making an important contribution to alleviating the precarious situation of the refugees. The German Archaeological Institute (DAI) is also involved in the region. Its project "Stunde Null (zero hour): A Future for the Time after the Crisis" has developed a package of measures that envisages

The AA launched the Philip Schwartz Initiative in 2015, which is run by the AvH acting as an intermediary. This initiative makes available for the first time a special programme for hosting threatened scientists at German universities and research institutions. The first 23 researchers started work at German universities in 2016, hailing from Syria (14), Turkey (6), Libya, Pakistan and Uzbekistan (1 each). From 2017 onwards, a further 24 scientists will be able to perform research at German institutions of higher education under this scheme.

Education and interaction can help to overcome adversity and crises. With their common language, scientists in particular are in a position to build bridges where diplomatic routes are barred or not yet in existence. This form of interaction creates

trust and understanding and smooths the way for politics.

The Federal Government's education policy measures in the target countries include the funding of third

country or Sur-Place scholarships for refugees to study at an institute of higher education in the region, such as the binational Turkish-German University or the German-Jordanian University. The BMBF is also funding the development of an Arab-German Young Academy (AGYA) in which young Arab and

German scientists carry out research together. A wide range of initiatives is underway in response to current societal challenges such as displacement and migration.

BMBF measures to integrate refugees into German institutions of higher education

Through the DAAD, the BMBF is funding more than 300 projects at over 180 institutions of higher education across the length and breadth of Germany to enable refugees to gain access to higher education. The BMBF launched a package of measures for this purpose at the end of 2015 and will be making some EUR 100m available in the next few years for these measures.

The objective is to give those refugees capable of studying some prospect of becoming an international student as quickly as possible so that they may one day return to rebuild their homeland as skilled workers or remain in Germany to work.

The core of the measures is the technical and linguistic preparation of refugees who hold higher education admission qualifications gained in their home country for professional studies in Germany. Through the BMBF-financed “Integra” programme, the DAAD is currently funding 172 projects offer 2,800 places at preparatory colleges (*Studienkollegs*) or similar institutions or on technical or language courses at institutions of higher education. In addition, the BMBF is funding 162 projects via the DAAD’s “Welcome – Students Helping Refugees” programme. Just under 700 student helpers at German institutions of higher education are

working in these projects, providing mentoring programmes, language support via learning cafés or small dedicated groups, or offering advisory services.



A further component of the measures is the identification and recognition of skills and qualifications: refugees in Germany who are interested in studying can take a free scholastic aptitude test and submit their applications for places on study courses. Fees for the Test for Academic Studies (TestAS) and for its assessment by the uni-assist service are paid for by the DAAD with BMBF funds. The procedure establishes whether the applicant is qualified to enter higher education.



5.2 Location marketing

The Federal Government believes that Germany must enjoy international visibility as a location for business and investment if German stakeholders are to be recognised abroad. The strengths of the location and appeal of a commitment to Germany must be systematically communicated worldwide in a campaign aimed at specific target groups. How Germany is seen as an attractive base for research, education and innovation depends not only on the conditions offered by the research location, but also on the perceptions of Germany abroad, some of which are determined by preconceived notions.

A long-term marketing campaign is to sharpen the image of Germany abroad as a high-performing location for science and technology and highlight ways to access its research landscape. The campaign should clearly show foreign target groups the added value to be found in collaboration in and with Germany when further developing their plans.

Germany has a whole range of successful initiatives which serve as a good basis for successful location marketing. These initiatives already cover all the significant areas of German stakeholder activity.

Campaigns such as *Study in Germany – Land of Ideas*, *Make it in Germany* together with the *Career Compass Germany* app provide information on living, working and studying in Germany.

Similarly, targeted marketing campaigns such as by the Higher Education Consortium GATE-Germany, or the iMOVE (International Marketing of Vocational Education) initiative on the internationalisation of vocational education and training, or special information portals (such as that on promotion of clustering) all contribute to recruiting young people for a stay in Germany.

In addition to the websites of the missions abroad and cross-media products such as www.deutschland.de or www.young-germany.de, the presentation of an updated image for Germany is also catered for by the Visitor's Programme of the Federal Republic of Germany.

The Federal Government will support the further development of these initiatives and, in doing so, will place special emphasis on more intensive inter-linking to increase their effectiveness.

The BMBF's Research Marketing Alliance opens participation up to new stakeholders. It is aligned with the International Cooperation Action Plan, which was also created by the BMBF. The concept is centred on a networked, target groupspecific approach and on empowering German research bodies to implement professionally measures of their own devising. Communication measures to raise awareness of Germany as a location for innovation and

research are being implemented worldwide under the "Research in Germany – Land of Ideas" brand.

Since 2005, the BMBF's International Year of Science events have been making an important contribution, not just to deepening the respective bilateral partnerships, but also to the international visibility of Germany. The Federal Government will link this commitment even more closely with other location marketing measures and coordinate it with related cross-departmental measures, such as the Federal Government's Germany Years. The BMBF will be submitting an appropriate plan on this matter.

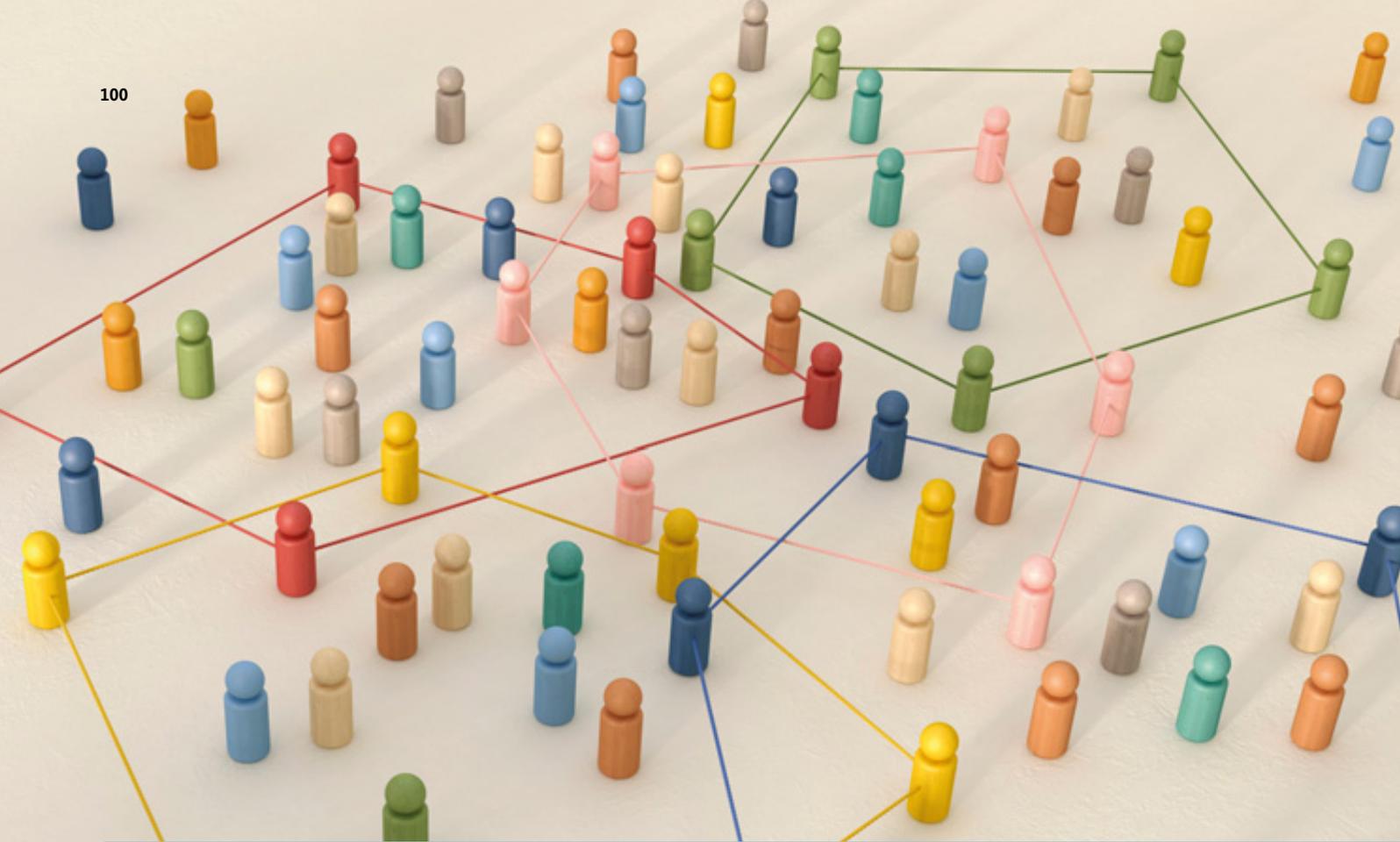
Alliance of Science Organisations – selected project

Exhibitions as an instrument of research and academic relations policy: the Science Tunnel example (MPG)

The MPG's Science Tunnel multimedia exhibition has been advertising Germany as a location for research and innovation since 2000. The exhibition content deals with basic research from virtually all the Max Planck Institutes, including on topics such as the universe, materials, health, energy, life and society. After premiering in Paderborn in October 2012, version 3.0 of the exhibition was presented in Moscow and St. Petersburg during 2013. In 2014, it was presented in São Paulo, Brazil, as part of Germany Year in Brazil, then travelling on to Beijing. Between late 2014 and early 2015, the exhibition was one of the beacon projects during the German-Turkish Year of Science when it was staged in Istanbul and Konya. After a stopover at the IdeenExpo in Hanover in July 2015 and an appearance in Cracow, Poland, the Tunnel started its tour of Latin America in Barranquilla (Colombia). The



Science Tunnel is once again one of the beacon projects of the Year of Germany in Mexico.



5.3 International presence

The presence of German organisations abroad – whether in the fields of education, research or innovation – is widespread and diverse. It is the visible expression of the growth of international networks and ranges from the foreign campuses of German higher education institutions and scientific institutions, via the AHK, through to subsidiaries of German companies. The DAAD has 15 regional offices abroad and 56 information centres in a total of 50 countries. They monitor the political, economic, social and higher education situation in their respective host countries and make their expertise available to German institutions of higher education. Conversely, they also offer the institutions of higher education, students and ministries in the host country an information and advisory service on the German higher education system and the options for studying in Germany.

Having presence abroad has immediate scientific, science policy and economic benefits: access to research topics and objects, access to resources in the form of personnel and infrastructure, broadening of skills, networking and cooperation with centres of excellence in the partner country, and tapping new sources of third-party funding.

By linking scientists from third countries to German institutions in the medium term, the foreign representations of German bodies can contribute to overcoming future shortages of skilled workers.

In accordance with the guiding principle of “International cooperation: networked and innovative”, the Federal Government will work toward closer coordination of German engagement abroad in coming years. The objective is to network more closely the technical activities abroad of various research and intermediary organisations with more research stakeholders. Activities in the target region should be implemented in a more coordinated and complementary way. The Federal Government has expanded the DWIH with the aim of more intensively highlighting the presence of German stakeholders abroad (see section 5.1 on the DWIH).

German humanities abroad

The Max Weber Foundation – German Humanities Institutes Abroad (MWF), under direct control of the BMBF, runs ten research institutes worldwide in Beirut, Istanbul, London, Moscow, Paris (with two institutes), Rome, Tokyo, Warsaw and Washington D.C., together with further research groups in Hong Kong, Cairo and New Delhi. As forums for international science, one function of the institutes is bridge-building between the host country and Germany. They promote dialogue across national boundaries, continents and disciplines within the humanities, social sciences and cultural studies, thus enhancing the visibility of top-class Ger-

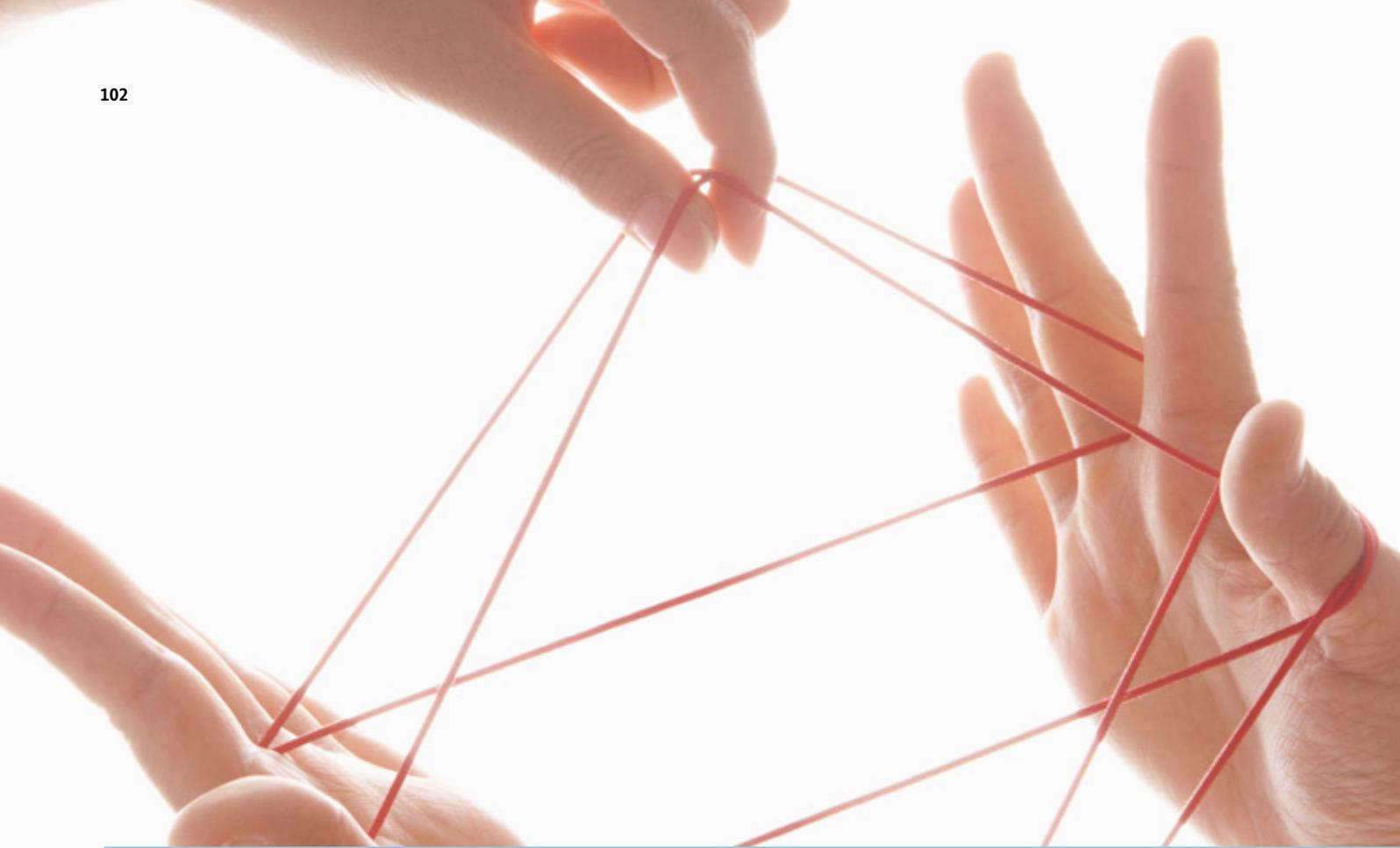
man research abroad and strengthening Germany as a location for science. The MWF has an annual budget of around EUR 40m. They currently employ a staff of 260 (full-time equivalent), of which 127 are academics. The Foundation's institutes also award approximately 350 scholarships every year to post-graduate and post-doctoral students. As an international body engaged in research in the humanities and social sciences, the MWF takes an active role in initiatives in the respective host countries aimed at networking the various scientific cultures.

The German Archaeological Institute – pioneer of international scientific cooperation

The German Archaeological Institute (DAI), a federal institute within the remit of the AA, is the oldest German research body outside the country. Founded in 1829, it operates a large number of departments both inside and outside Germany. These include institutes and commissions with affiliated libraries in Berlin, Bonn, Frankfurt and Munich as well as in Madrid, Rome, Athens, Istanbul, Baghdad, Damascus, Tehran, Sana'a, Cairo and Beijing. The DAI's projects foster international scientific dialogue and support collaborations with numerous host and partner countries. Research projects are currently running in approximately 40 countries, with a staff of 238 at the various institutes. The DAI's libraries and archives provide a significant infrastructure. They are open to young scientists and researchers from the host country and, as part of academic relations policy, serve as important locations for two-way networking. The DAI

is also involved in the creation and redesign of digital infrastructures for the study of ancient civilisations and recently set up a research network in Africa.





5.4 New formats for international cooperation

The dynamic development of R&I has given rise to a multifaceted structure of international and regional bodies and formats. In addition to the bilateral and multilateral forums for dialogue with partner countries, there are the governance and dialogue processes of supranational and international organisations, such as the OECD and the UN.

One major priority of the Federal Government over the coming years is to help to reform and reshape these governance processes. Stronger links should be established between the existing formats and synergies exploited wherever possible. The task is to network the numerous bilateral and multilateral, regional and global decision-making processes in such a way as to ensure that decisions taken are actually implemented.

For this reason, the Federal Government wants to review its involvement in the various bodies and forums and, where necessary, redirect its activities in the light of its strategic interests in education, science and research. The particular priority is an efficient networking of the bilateral and European formats.

The Federal Government will also work to ensure that activities in the existing international and European formats are more closely networked. The existing formats should also be further developed. The meetings of the G7 science ministers have proved their worth and, following on from the 2015 meeting, should be established as a regular forum. This is also true of meetings of the G7 transport ministers, at which the coordination of mutually aligned research projects on automated and connected vehicles is a key topic.

The bilateral coordination processes are to be refined and interlinked as necessary with other industrialised countries and emerging scientific economies in the coming years. This applies among others to the STC agreements. The Federal Government will increasingly

accompany bilateral cooperation, especially in the area of the STC agreements, with a multilateral element. The option of multilateral STC agreements should be further developed with other European partners. In the case of the EU agreements, the Federal Government aims to strengthen the involvement of Member States.

Against this background, the Federal Government will perform regular location and policy analyses with respect to its partner countries, thereby taking better account of changing priorities, resources and parameters.





6 Monitoring

The Federal Government sees a broad and reliable information base as a precondition for an evidence-based policy on the internationalisation of education, research and innovation. Monitoring is currently characterised by a variety of national, European and international processes. These sometimes cover separate and partly overlapping areas and sectors and are mostly independent of each other. The Federal Government will work to harmonise the reporting requirements as regards content, method and timing.

A representative national monitoring system is lacking to date. The Federal Government intends to close this gap by supplementing and integrating existing components into an overall system and dovetailing it with European and international processes.

The task includes developing a set of generally accepted indicators that describe the quality of the international dimension of an innovation system. These should allow a direct comparison to be made with other countries and permit alignment of the strategies of other countries on the internationalisation of science and innovation.

In addition, an internationally accepted benchmarking procedure should allow the degree of internationalisation of the German science and innovation system to be compared with other countries and developments at the European and international level to be analysed. Existing monitoring reports, such as those in the Pact for Research and Innovation, are being further developed.

International cooperation issues also form part of the EMM. The Federal Government will work to achieve closer dovetailing of European and international processes with national monitoring activities. This will require, for example, aligning data collection for the ERA Roadmap with national collection systems. When doing this, it must be ensured that the national and European monitoring processes are sufficiently aligned to data collection by the OECD and UN.

Against a background of numerous monitoring activities occurring at the various levels (national, European and international), the Federal Government will, in addition to aligning the content, also work towards an improved and more effective harmonisation of the processes involved so as to reduce the cost and effort of reporting for the stakeholders involved – where possible and expedient – without diminishing the quality of an effective accounting.

From 2017 onwards, the Federal Government will report to the Bundestag every two years on the state of international (including European) cooperation in education, science and research.

Alliance of Science Organisations – selected project

Profile data on the internationality of German institutions of higher education (HRK, DAAD and AvH)

Since 2006, the HRK, DAAD and AvH have been working with the Group of Experts for Empirical Studies (*Gesellschaft für Empirische Studien*) on a service project to collect profile data on the internationality of German institutions of higher education. The roughly 50 quantitative indicators provide an impression of the degree of internationalisation in Germany's higher education sector. This is done annually by evaluating data on international activities collected systematically by either the participating scientific organisations or the Federal Statistical Office. As a complement to the HRK audit's qualitative approach, the results help the institutions of higher education to compare themselves at the national level within one of six clusters (based on type and size) and to use this as a basis for positioning themselves strategically. The indicators, aggregated to cluster level and providing an estimate of the degree of interna-

tionalisation in the higher education sector, are also available to political decision-makers and the public on the HRK web site.



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List of Abbreviations

AA	Federal Foreign Office
AGNES	African-German Network of Excellence in Science
AHK	German Chambers of Commerce Abroad
AIMS	African Institutes for Mathematical Sciences
ArcHerNet	Archaeological Heritage Network
ASEM	Asia-European Meeting
ATTO	Amazonian Tall Tower Observatory Facility
AU	African Union
AvH	Alexander von Humboldt Foundation
BAföG	Federal Training Assistance Act
BAW	Federal Waterways Engineering and Research Institute
BDA	Confederation of German Employers' Associations
BfArM	Federal Institute for Drugs and Medical Devices
BfR	Federal Institute for Risk Assessment
BIBB	Federal Institute for Vocational Education and Training
BMAS	Federal Ministry of Labour and Social Affairs
BMBF	Federal Ministry of Education and Research
BMEL	Federal Ministry of Food and Agriculture
BMG	Federal Ministry of Health
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BMVg	Federal Ministry of Defence
BMVI	Federal Ministry of Transport and Digital Infrastructure
BMWi	Federal Ministry for Economic Affairs and Energy
BMZ	Federal Ministry for Economic Cooperation and Development
BNITM	Bernhard Nocht Institute for Tropical Medicine
BQ Portal	Information portal for foreign qualifications
BRICS	The emerging national economies Brazil, Russia, India, China and South Africa
BTF	Bilateral Trust Fund
CAMEXA	Cámara Mexicano-Alemana de Comercio e Industria (German-Mexican Chamber of Commerce and Industry)
CGIAR	Consultative Group on International Agriculture Research
CLIENT	International partnerships for sustainable innovation, a BMBF funding programme
CREATE	Collaborative Research and Training Experience
DAAD	German Academic Exchange Service
DAFI	Albert Einstein German Academic Refugee Initiative
DAI	German Archaeological Institute
DESERVE	Dead Sea Research Venue

DFG	German Research Foundation
DGB	German Trade Union Confederation
DIHK	Association of German Chambers of Commerce and Industry
DKFZ	German Cancer Research Center
DLR	German Aerospace Center
DWIH	German Research and Innovation Houses
DZHW	German Centre for Higher Education Research and Science Studies
ECTS	European Credit Transfer and Accumulation System
ECVET	European Credit System for Vocational Education and Training
EDCTP	European and Developing Countries Clinical Trials Partnership
EFSI	European Fund for Strategic Investments
EIB	European Investment Bank
EIC	European Innovation Council
EIP	European Innovation Partnerships
EIT	European Institute of Innovation and Technology
EMLabs	European Mobile Laboratories
EMM	European Monitoring Mechanism
EMPIR	European Metrology Programme for Innovation and Research
EQAR	European Quality Assurance Register for Higher Education
EQF	European Qualifications Framework
ERA	European Research Area
ERAnet	European Research Area Network
ERC	European Research Council
ESD	Education for Sustainable Development
ESF	European Social Fund
ESFRI	European Strategy Forum on Research Infrastructures
ESG	Standards and Guidelines for Quality Assurance in the European Higher Education Area
ET 2020	Education and Training 2020
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FGU	Franco-German University
FhG	Fraunhofer Society for the Promotion of Applied Research
FLI	Friedrich Loeffler Institute
FONA	Research for Sustainable Development
FPR	EU Framework Programme for Research and Technological Development
FZB	Research Center Borstel – Leibniz-Center for Medicine and Biosciences
G20	Group of 20
G7	Group of 7
G8	Group of 8
GAIN	German Academic International Network
GDP	Gross Domestic Product

GFCS	Global Framework for Climate Services
GFFA	Global Forum for Food and Agriculture
Globe	Securing the Global Food Supply
GOVET	German Office for International Cooperation in Vocational Education and Training
GRC	Global Research Council
GSF	Global Science Forum
GSO	Group of Senior Officials on Global Research Infrastructures
HGF	Hermann von Helmholtz Association of German Research Centres
HPI	Heinrich Pette Institute, Leibniz Institute for Experimental Virology
HRK	German Rectors' Conference
ICSU	International Council for Science
ICT	Information and Communication Technologies
IGS	International Graduate School
iMOVE	International Marketing of Vocational Education
IMPRS	International Max Planck Research Schools
INPA	Instituto Nacional de Pesquisas da Amazônia
IP	Intellectual Property
IPBES	Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IQ	"Integration through Qualification" support programme
IT	Information Technology
ITER	International Thermonuclear Experimental Reactor
JPI	Joint Programming Initiative
KCCR	Kumasi Center for Collaborative Research in Tropical Medicine (Ghana)
KfW	KfW Group
KICs	Knowledge and Innovation Communities
KMK	Standing Conference of the Ministers of Education and Cultural Affairs of the <i>Länder</i> in the Federal Republic of Germany
LCI	Leibniz Center Infection
LHC	Large Hadron Collider
MENA	Middle East and North Africa
MINT	Mathematics, Informatics, Natural sciences and Technology
MMFD	Modelo Mexicano de Formación Dual (Mexican system of dual vocational training)
MOST	Ministry of Science, Technology and Space (Israel)
MPG	Max Planck Society
MWF	Max Weber Foundation – German Humanities Institutes Abroad
NPE	National Platform on Electric Mobility
NSERC	National Science and Engineering Research Council (Canada)
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PAU	Pan-African University

PAUWES	PAU hub in Algeria
PDP	Product Development Partnerships
PEI	Paul Ehrlich Institute
PIAAC	Programme for the International Assessment of Adult Competencies
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
R&D	Research and development
R&I	Research and Innovation
RKI	Robert Koch Institute
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Management
SDGs	Sustainable Development Goals
SME	Small and Medium-Sized Enterprises
STC	Scientific and technical cooperation
STIBET	Scholarship and Assistance Programme of the DAAD
TFEU	Treaty on the Functioning of the European Union
TIMSS	Trends in International Mathematics and Science Study
TNE	Transnational education
TVET	Technical and vocational education and training
UEA	Universidade do Estado do Amazonas (Brazil)
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNEVO	International Centre for Technical and Vocational Education and Training
UNHCR	United Nations High Commissioner for Refugees
USA	United States of America
VET	Vocational education and training
VGGT	Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security
WASCAL	West African Science Service Centre on Climate Change and Adapted Land Use
WGL	Leibniz Association
WMO	World Meteorological Organization
XFEL	X-Ray Free-Electron Laser
YESS	Young Earth System Scientists
ZDH	German Confederation of Skilled Crafts
ZIM	Central Innovation Programme for SMEs

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