



Federal Ministry  
of Education  
and Research



German-Chinese Cooperation  
in Science and Research

# China Strategy 2015–2020

Strategic Framework for Cooperation with China in Research, Science and Education





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## Foreword

In recent decades, China has not only developed in terms of its economy, but also in science and research. In many fields it has caught up with the leading industry and science nations. Germany's science and research community has a great interest in participating in these developments in China and in working with Chinese partners to find innovative solutions to today's global challenges.

German-Chinese cooperation in research, education and innovation has especially intensified in recent years. This is partly due to the intergovernmental consultations between the two countries that have been held since 2011. As strategic partners, Germany and China work to foster research and innovation to the mutual benefit of their countries. In the context of this cooperation we have set up many successful joint projects and activities – particularly in areas such as water, climate, environment, sustainability, innovation research, life sciences, electric mobility as well as in higher education and vocational education and training.

We aim to both expand and further intensify German-Chinese cooperation in education and research. To ensure the success and the mutual benefits of future cooperation activities, we must critically analyse our previous efforts and define goals and concrete measures for further cooperation. The China Strategy of the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF) provides the necessary framework and paves the way for the future. I look forward to further cooperation with our partners in China.

A handwritten signature in black ink, reading "Johanna Wanka". The signature is written in a cursive, flowing style.

Prof. Dr. Johanna Wanka  
Federal Minister of Education and Research



## 1. Why a China Strategy?

In recent decades, the Chinese economy has developed more dynamically than that of any other country in the world, resulting in greater political influence, not just in Asia, but globally. After overtaking Germany in 2007 as the third-largest economy, China knocked Japan from second place in 2010. In the coming years, it might overtake the US, establishing itself as the largest economy in the world. If Gross Domestic Product (GDP) is adjusted for purchasing power parity (PPP), China has overtaken the US in 2014 already.

The combination of huge production capacity and low production costs saw China become the world's 'manufacturing powerhouse' in the 1990s. In recent decades, China has transitioned from a developing country to an emerging economy – in some respects it is already an industrialised nation. Achieving the transition to an innovation nation has been the Chinese government's declared aim since the turn of the millennium (moving from 'made in China' to 'invented and designed in China'). One of the catch-words in this context is 'indigenous innovation'. The modernisation of the inno-

vation system is to be achieved by means of structural reforms, the forming of international partnerships and large-scale financial investment in education, research, technology and innovation.

According to the OECD Development Assistance Committee, China ranks as an 'upper middle income country'. This means that foreign payments that flow into China can, under certain circumstances, be declared as Official Development Assistance (ODA). At the same time, China has become a donor country itself (providing more development aid than the World Bank) and is active in all regions of the world, especially in Africa.

In today's globalised world, it is no longer a question of whether German science and industry should cooperate with China. Rather, it is a question of identifying appropriate objectives, thematic areas, actors and collaboration mechanisms so that such cooperation benefits Germany. Cooperation with China is necessary to jointly develop knowledge and technology, strengthen

Germany as a research and innovation location, open up the Chinese market for German companies and find solutions to the great social and environmental challenges of our time. Thus, for Germany, cooperation with China is an ‘unmissable opportunity’ that has to be grasped.

## 1.1 Innovation and economic development: Priorities of the Chinese government

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The Chinese government set out its research policy requirements in plans such as the National Medium- and Long-Term Program for Science and Technology Development (2006–2020) and the 12th Five-Year Plan (2011–2015). These include the objective of increasing research and development (R&D) expenditure to a minimum of 2.5 percent of GDP per year in the period up to 2020. By that same deadline, only 30 percent of the technology needed is to be imported from abroad and Chinese scientists should rank among the world’s Top 5 when it comes to patents and citations.

With this ‘innovation initiative’, China wants to establish itself as a location for the development and production of high-technology products. The aim is to overcome the technology gap and become a technology leader. The associated set of measures reflects the government’s determination to transform China into an innovation-focused nation by 2020 – one that exports cutting-edge technologies and successfully competes with the world’s leading industrialised nations. Concrete measures include significantly increased investment in science and technology (S&T), tax incentives, financial assistance in government procurement, protection of intellectual property rights (IPR) and the promotion of young scientists. China wants to develop an economy which combines the service industry with a modern manufacturing industry. Renewable energies, materials, environmental protection, biopharmaceuticals, telecommunications and internet applications are all deemed strategically important industries.

Investment in higher education has risen steadily in China in recent years as well. Public expenditure on higher education almost quadrupled in the period

2006 to 2012. To ensure that China’s higher education institutions join the world’s elite, various funding programmes (e.g. the 211 Program, the 985 Program) were introduced to give selected institutions the financial assistance they need to become top-class research establishments.

China’s political system is controlled centrally from Beijing and, despite earlier decentralisation measures, tends to take a more top-down approach. Nonetheless, provincial governments and other stakeholders (such as local and regional science and technology commissions) are playing an increasingly important role in China’s innovation landscape. Since the 11th Five-Year Plan (2006–2010) was implemented, the plans have been less in the nature of ‘instructions’ from central government and take more of a macro-management approach. This gives the provincial governments enough autonomy to define their own research policy focus areas while adhering to the strategic requirements and to decide independently on how to spend the available budget. In many instances, the regional and local stakeholders are more flexible and thus faster in their decision-making than institutions operating at central level. Under the 11th Five-Year Plan, the city of Beijing for instance spent a total of RMB 75.8 billion (about EUR 9.1 billion) on some 1,200 projects. To secure a better position in country-wide competition, regional and local stakeholders expend great effort in establishing international contacts, in some cases financing a significant portion of the costs of cooperation projects conducted with foreign partners and offering incentives for foreign research centres to set up premises in the respective regions.

## 1.2 Cooperation with China brings opportunities and challenges

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The Chinese government has recognised that its economic and environmental policies must be adjusted if the country is to achieve ongoing economic growth and at the same time to address increasing social and economic disparities. This development offers new opportunities for German-Chinese cooperation in science, research and innovation.

**Table 1 Economic facts and figures for Germany and China**

	Germany	China
Inhabitants (2014)	80.9 million	1.36 billion (17 times as many as Germany)
Area (2014)	357,340 km <sup>2</sup>	9,596,960 km <sup>2</sup> (27 times bigger than Germany)
GDP (2014)	USD 3,859 billion <sup>1</sup> [approx. EUR 2,907 billion]	10,380 billion USD [approx. EUR 7,821 billion]
GDP per capita (2014)	USD 46,843 [approx. EUR 35,298]	USD 7,589 [approx. EUR 5,718]
Economic growth (2014)	1.6%	7.4%
Foreign trade (2014)	German imports from China: EUR 79.3 billion	German exports to China: EUR 74.5 billion
Imported/exported goods (2014)	Chinese exports to Germany: <ul style="list-style-type: none"> <li>● Electronics 31.0%</li> <li>● Textiles/Clothing 12.7%</li> <li>● Electrical equipment 11.0%</li> <li>● Machinery 6.7%</li> <li>● Chemical products 4.4%</li> <li>● Other 34.2%</li> </ul> 8.7% of all imports to Germany (2nd place)	German exports to China: <ul style="list-style-type: none"> <li>● Vehicles/automotive parts 28.2%</li> <li>● Machinery 24.8%</li> <li>● Electrical equipment 10.1%</li> <li>● Chemical products 8.8%</li> <li>● Measuring and control technology 5.7%</li> <li>● Electronics 3.5%</li> <li>● Other 18.9%</li> </ul> 6.6% of all German exports (4th place)
Direct investment (2013)	German direct investment in China: EUR 47.81 billion	Chinese direct investment in Germany: EUR 1.19 billion
Global Competitiveness Index (2014/2015)	5th place among 144 countries	28th place among 144 countries
Global Innovation Index (2014)	13th place among 143 countries	29th place among 143 countries

Sources: Germany Trade and Invest (GTAI): Compact economic data China and Germany (in German only, May 2015), Global Innovation Index 2014.

1 The following is based on the average currency exchange rates for the respective years: USD 1 = EUR 0.77806 (2012), EUR 0.75316 (2013), EUR 0.75354 (2014) and RMB 1 = EUR 0.12311 (2012), EUR 0.12151 (2013), EUR 0.12257 (2014).

German companies have played an important role in China's technological modernisation to date. Given the country's size and its continued economic growth, German companies see lucrative development opportunities and are willing to set up operations and make long-term investments in China under what in some cases are rigid conditions (such as forced joint ventures with Chinese state-run enterprises and stipulations regarding the creation of production and research capacities).

To be successful in the Chinese market, foreign products and services must be adapted to meet both local consumer needs and local standards through research and development activities undertaken in China. These adapted solutions and the experience gained in their development can be used to open up other markets, especially in Asia.

China's economic and technological growth is linked to huge social challenges which German technology and expertise can help tackle:

- large-scale, continuing urbanisation (the emergence of new mega-cities<sup>2</sup>) and the associated need to develop modern transportation systems and other infrastructures (water, waste and energy)
- a rural exodus that accompanies urbanisation (by 2025 it is expected that 70 percent of the Chinese population will live in cities – this compares with over 50 percent in 2013 and 20 percent in 1978) coupled with the social circumstances of the approximately 270 million migrant workers (who account for about one fifth of the total population)
- serious environmental pollution (air, water and soil), the risk to biodiversity and the threat of climate change due to increasing resource and energy use
- growing disparities between large cities and developed coastal regions in the east and economically backward regions, especially in the west

- an increasing imbalance between a growing urban middle-class and the mostly poorer rural population<sup>3</sup> and the resulting social problems
- an ageing society (especially in rural areas)

At the same time, given the prevailing conditions, China serves as an important testing ground for German research and industry, and is a key market for the development of adapted technology solutions. The German Company Directory Greater China published by the German Chamber of Commerce (AHK) lists more than 5,000 German companies that are currently active in China. Many large-scale German enterprises have already established production and sales operations in China and cooperate with Chinese partners from research and industry.

But cooperation of any kind also brings challenges and risks. In China, these include the incredible pace of the country's political, economic and social development, the great complexity in the distribution of responsibilities, the frequently low transparency in decision-making at political level and information which is in some cases insufficient or difficult to obtain.

The country's size, the almost unmanageable number of political actors and the various levels of national, regional and local government, all of which are supplemented by parallel structures of the Communist Party, can make it difficult to initiate and conduct cooperation activities. The situation is aggravated by the fact that many in the German education and R&D sectors have only limited knowledge of modern China and are thus unable to anticipate the challenges involved in pursuing German-Chinese collaboration.

Apart from the goal of more intensive cooperation, there is also a risk of increased competition in the race for markets, technology and knowledge. The Chinese government links the gradual opening of the Chinese market with concrete requirements for foreign cooperation partners to transfer technology and know-how to China. The aim of future cooperation with China must thus be to take the prevailing conditions and

2 China is the most populous country in the world and the fourth-biggest in terms of size. The three most-densely populated provinces each have around 100 million inhabitants. Added to these are megacities such as Beijing and Shanghai with populations of more than 20 million. There are currently more than 120 prefectural-level cities with at least one million inhabitants each.

3 According to the World Bank, the extreme poverty rate in China fell from 84 percent in 1981 to 12 percent in 2010. At the end of 2012, approximately 100 million Chinese were living below the national poverty line of RMB 2,300 (about EUR 283) per year.

requirements into account when conducting cooperation activities, and to move away from the paradigm of market access (solely) in return for technology transfer and towards cooperation on a level playing field.

### 1.3 The BMBF China Strategy as a basis for bilateral cooperation in research, science and education

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As the responsible federal ministry for German research, science and education cooperation, the BMBF drafted its China Strategy to exploit the opportunities that arise from cooperation with China, setting out a systematic approach to tackling the challenges and risks involved. This country strategy is part of the Strategy of the Federal Government for the Internationalisation of Science and Research. Its guiding principle is to provide a framework within which cooperation with China focuses on the strategic interests of Germany. German science, research and industry must position themselves in such a way that they benefit to the greatest extent possible from current trends and future developments in China.

The China Strategy provides a coherent, systematic framework for the BMBF's cooperation with China in education, research and innovation in the period 2015 to 2020.<sup>4</sup> The Strategy is an important contribution to the China policy of the Federal Government.

The Strategy was developed over a period of several months and involved seven expert commissions<sup>5</sup> comprising more than 70 representatives from science and industry. They produced thematic analyses and drafted recommendations for action, taking into account the activities and interests of and the experience gained by German higher education institutions, research institutes, intermediary and funding organisations,

(vocational) education providers and industry (small and medium-sized enterprises (SMEs), multi-nationals, industry associations and chambers of industry and commerce).

In a next step, the findings of the expert commissions were evaluated by the BMBF and then compared with the goals and priorities of the new High-Tech Strategy from 2014, the Strategy of the Federal Government for the Internationalisation of Science and Research from 2008, the BMBF's International Cooperation Action Plan published in autumn 2014 and the German Foreign Office's China Strategy. Finally, the outcomes from this detailed evaluation were used to draw up a set of concrete measures and activities.

This China Strategy contributes to the implementation of the comprehensive strategic partnership between Germany and China agreed by Chancellor Angela Merkel and President Xi Jinping during the President's official visit to Germany at the end of March 2014.

This document provides a snapshot of the current situation and the opportunities for and challenges involved in cooperation with China in 2014/2015. It is to be expected that in the coming years, the Chinese research, innovation and education landscape will encounter more of the rapid development seen in recent times. The pace of this development calls for regular review of the goals and measures which could result in further development and adjustment of the China Strategy.

Section 2 of this document provides an overview of China's education, research and innovation landscape and policies. Section 3 describes the current cooperation activities of the BMBF and those of German research, funding and intermediary organisations as well as of the European Union (EU). Section 4 sets out the goals, guiding principles and points for consideration regarding future German-Chinese cooperation, and section 5 provides a detailed presentation of the various activity areas involved and future cooperation measures.

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<sup>4</sup> See also the recommendations in the Commission of Experts for Research and Innovation's report on research, innovation and technological performance in Germany ('EFI report') from 2012.

<sup>5</sup> The seven expert commissions worked on the following topics: 1) Life sciences, 2) Information and communications technology (ICT), 3) Key technologies (materials research, production research, photonics, microelectronics and electric mobility), 4) environmental technology, water, climate, geosciences, marine and polar research, 5) renewable energies, 6) higher and vocational education, the humanities and social sciences, 7) cross-cutting issues.



## 2. Research, innovation and education in modern China

To assist in understanding subsequent sections, it is helpful to give a brief overview of China's education, research and innovation policy goals and structures, the stakeholders responsible and the thematic priorities and (funding) programmes designed for their implementation.

### 2.1 China's path towards becoming a global leader

Quantitatively speaking, China is already one of the strongest research countries in the world. In the past fifteen years, it has increased its R&D expenditure as a share of GDP from 0.9 percent (2000) to 1.32 percent (2005) and then to 2.08 percent (2013). In 2015, **R&D expenditure** is expected to amount to 2.2 percent of GDP. The 2.5 percent goal for 2020 appears to be reachable. Since 2001, R&D expenditure has risen by just under 17 percent per year. In absolute terms,

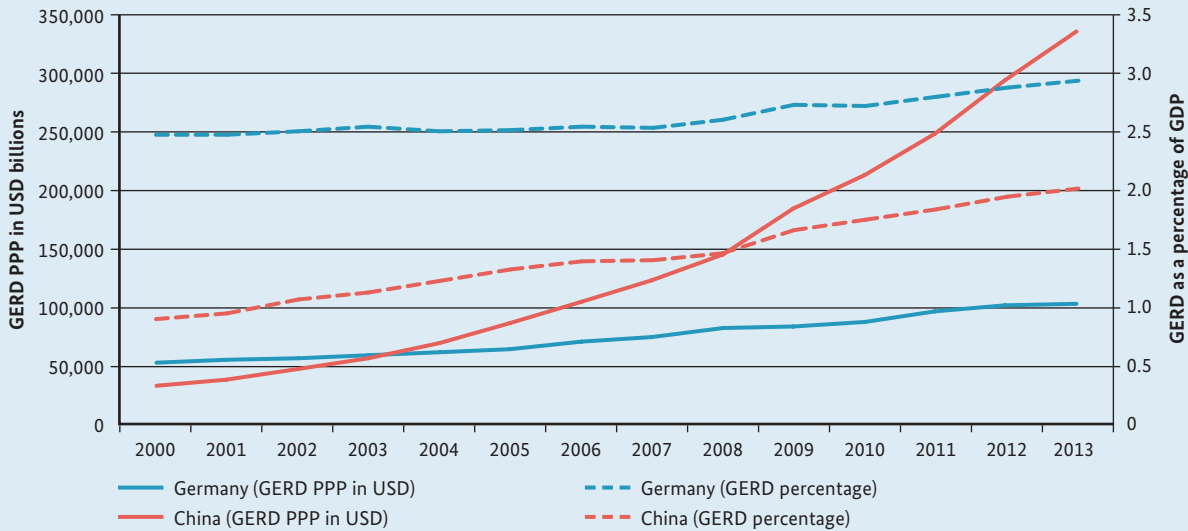
China could soon overtake the US as number one.<sup>6</sup> In 2013, China spent some USD 336.5 billion (approximately EUR 253 billion) on R&D (this compares with USD 457 billion/EUR 344 billion in the US, and USD 101 billion/EUR 76 billion in Germany).

Another impressive example of the rapid development of China's R&D sector is the number of its **patent applications**. Since the country's first patent law entered into force in 1985, the number of patent applications initially rose slowly, but by the end of the 1990s, it was growing dramatically.<sup>7</sup> In 2014, some 928,000 patents were applied for in China (of which 127,000 were from abroad). Approximately one in four of these were approved. Of the approved patents, one in three came from outside China (70,548 out of 233,228). As regards the number of patent applications submitted under the Patent Cooperation Treaty, China overtook Germany in 2011 and ranked third behind the US and Japan in

<sup>6</sup> Batelle (2013): 2014 Global R&D Funding Forecast.

<sup>7</sup> European Patent Office (2014): Facts and Figures China 2014.

**Figure 1 R&D expenditure in Germany and China**  
(in absolute figures and as a share of GDP for the period 2000–2013)



Source: OECD Main Science and Technology Indicators.

2014 with 25,539 patents.<sup>8</sup> It must, however, be noted that the growing number of patent applications is by no means an indication of their quality and innovative content. This is partly due to distorted state incentive systems (with a focus on incremental innovation and design adaptation for the Chinese market, applications for ‘junk patents’ and copyright and trademark patents rather than on invention patents). Despite the strong rise in the registration of domestic patents in recent years, China is spending almost twenty-four times more on the use of foreign IPR than it generates in revenue from Chinese IPR.

With regard to the absolute number of **publications**, China has caught up strongly in the past ten years, ranking second behind the US in 2014. However, in the global ranking for **citation frequency** (in terms of the H-Index for 1996–2013) China ranks only sixteenth on average for all fields. In areas such as materials science, chemicals and energy, the H-Index is significantly higher. In international comparison, China ranks sixth in these fields.

China’s strengths and weaknesses in different research fields can be deduced from the distribution of publications across all the various disciplines compared to average figures for the world in 2014. Relative strengths include engineering science, materials science, ICT and chemicals. A relative weakness can be seen in medicine. It must, however, be noted here as well that the strong increase in publication numbers is partly due to the introduction of a financial incentive system for publications appearing in selected journals.

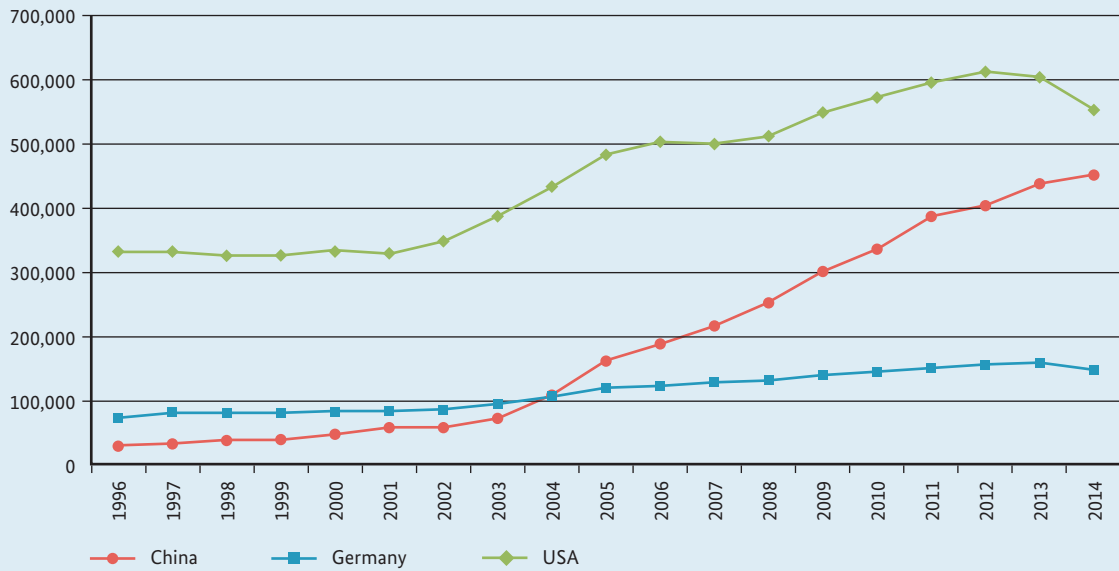
**Table 2 Revenue from and expenditure on IPR in Germany and China (2013)**

	Revenue from IPR	Expenditure for IPR
<b>Germany</b>	USD 13.11 billion [EUR 9.87 billion]	USD 8.42 billion [EUR 6.34 billion]
<b>China</b>	USD 886.6 million [EUR 667.7 million]	USD 21.03 billion [EUR 15.84 billion]

Source: World Bank World Development Indicators 2015.

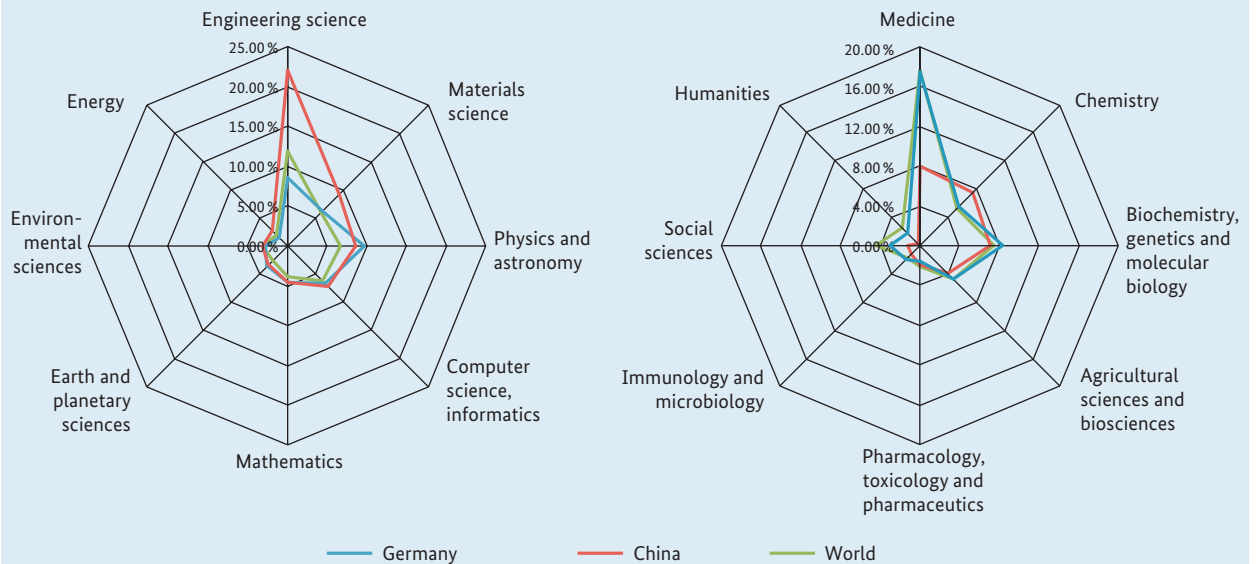
8 World Intellectual Property Organization (2014): Infographics 2014.

**Figure 2 Trend in publication figures in Germany, China and the US (1996–2014)**



Source: SCImago.<sup>9</sup>

**Figure 3 Distribution of German, Chinese and global publications in selected thematic fields (2014)**



Source: SCImago.

China’s scientific base is equally without comparison: according to official statistics, in 2013 some 32 million Chinese were enrolled in higher education institutions and around seven million obtained a higher educa-

tion degree. There is also a large pool of Chinese who are currently studying or researching abroad. At the moment almost 400,000 Chinese are studying at higher education institutions outside China. In 2012, Chinese students made up the largest share (22 percent) of all international students in OECD countries. The greatest proportion of Chinese studying abroad do so in the

<sup>9</sup> SCImago is based on the Elsevier Scopus citation database, which comprises almost 22,000 titles from over 5,000 international publishing houses in diverse fields.

US (28 percent), followed by those in Japan (13 percent), Australia and the UK (both with 11 percent), South Korea (6 percent), Canada (5 percent), France (3.5 percent) and Germany (3 percent).<sup>10</sup> In 2014, just over 10 percent

of all foreign students in Germany were from China (30,511 out of 301,350), making them by far the largest group.<sup>11</sup>

**Table 3 Research and education data of Germany and China**

	Germany	China
Gross domestic expenditure on R&D (GERD) in local currency (2013) (A)	EUR 80.16 billion	RMB 1.18 trillion [approx. EUR 143.4 billion]
GERD (PPP) (2013) (A)	USD 100.9 billion [approx. EUR 76.0 billion]	USD 336.5 billion [approx. EUR 253.43 billion]
GERD as a percentage of GDP (2013) (A)	2.85%	2.08%
Percentage of GERD financed by industry (2013) (A)	65.2%	74.6%
Number of researchers (fulltime equivalent) (2013) (A)	360,364	1,484,039
Number of researchers (fulltime equivalent) per million inhabitants (2012) (B)	4,139	1,020
Number of R&D personnel (fulltime equivalent) (2013) (A)	603,860	3,532,816
Triadic patent families (2013) (A)	5,465	1,785
Patent registrations under the Patent Cooperation Treaty (2014) (C)	18,008	25,539
Publications in the Scientific Citation Index (17.07.2015) (D)	2.18 million	3.62 million
Expenditure on education (2012) (E, F)	EUR 178.4 billion	RMB 2.77 trillion [approx. EUR 330 billion]
Expenditure on education as a percentage of GDP (2012) (E, F)	6.5%	4.28%
Higher education institutions (2012) (E, G)	428 Comprising 183 universities (incl. educational, theological and art colleges) and 245 universities of applied sciences (incl. business administration colleges).	2,442 Of which around half offer basic four-year and half offer three-year occupation-focused studies. Only 811 institutions offer Masters programmes and postgraduate opportunities.
Students (2013) (E, G)	2.6 million	31.46 million <sup>12</sup>
Higher education degrees (2012) (E, G)	413,338	6.8 million
Students studying overseas (2012) (G)	German students in China: 6,200 Foreign students in China: 328,330	Chinese students in Germany: 23,833 Chinese students studying overseas: 399,600

Sources: (A) OECD Main STI Indicators, (B) World Bank World Development Indicators 2015, (C) World Intellectual Property Organization: Infographics 2014, (D) SCImago Country Ranking, (E) BMBF database, (F) Ministry of Education of the People's Republic of China (MoE): Report on government spending on education in 2012 (in Chinese only), (G) German Academic Exchange Service (DAAD): Economy, politics and higher education in the People's Republic of China (in German only).

<sup>10</sup> Organisation for Economic Co-operation and Development (2014): Education at a Glance 2014 – OECD Indicators, p. 350 ff.

<sup>11</sup> Wissenschaft weltoffen 2015, table 1.6.1.

<sup>12</sup> This includes students in two and three-year vocational training courses and those studying online. The number of students who meet the German definition of students in higher education (studying four-year foundation [Bachelor] programmes, Masters and PhD students) was 16.7 million.

## 2.2 Stakeholders in the education and research system

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The institutional framework of China's education and research landscape includes diverse stakeholders at national, regional and local level. The following describes the key stakeholders and their roles.

The leading role of the **Communist Party**<sup>13</sup> in policy-making and governance is enshrined in the constitution of the People's Republic of China. The highest decision-making authority in the Communist Party, the **Central Committee**, usually meets once a year in a plenary session in October where it decides on general strategic direction and fundamental issues. These decisions are then transformed into laws and regulations. The Central Committee appoints, promotes and dismisses not only members of the Party, but also top managers in the business sector. And with organisations such as the All-China Federation of Trade Unions, the Communist Party also permeates Chinese industry. The **Politburo**, comprising 25 high-level members of the Communist Party, calls Central Committee meetings, decides government policy and is overseen by the seven-member **Standing Committee of the Politburo**, the Party's real centre of power. China's current President Xi Jinping is also the Secretary General of the Communist Party and Chair of the Central Military Commission, making him the country's highest-ranking official and functionary.

The **National People's Congress** (NPC) is the parliament of the People's Republic of China and with some 3,000 members (of which more than two-thirds are members of the Communist Party) is the largest parliament in the world. The NPC exercises state legislative power and meets once a year in March. It has nine thematic committees, including one for education, science, culture and public health. In the periods between the NPC meetings, legislative work is performed by a Standing Committee comprising 150 members.

The most important executive body is the **State Council**, which is headed by Prime Minister Li Keqiang and has very close ties with the Communist Party. With very few exceptions, the State Council is made up of high-ranking Party officials.

In centrally governed China, the ministries, academies and funding organisations responsible for education, research and innovation report directly to the State Council. Within the State Council, the **National Leading Group for Science and Education** (also known as the National Steering Committee) decides on respective national strategies and research programmes, and coordinates the research policies of the respective ministries and regional governments.

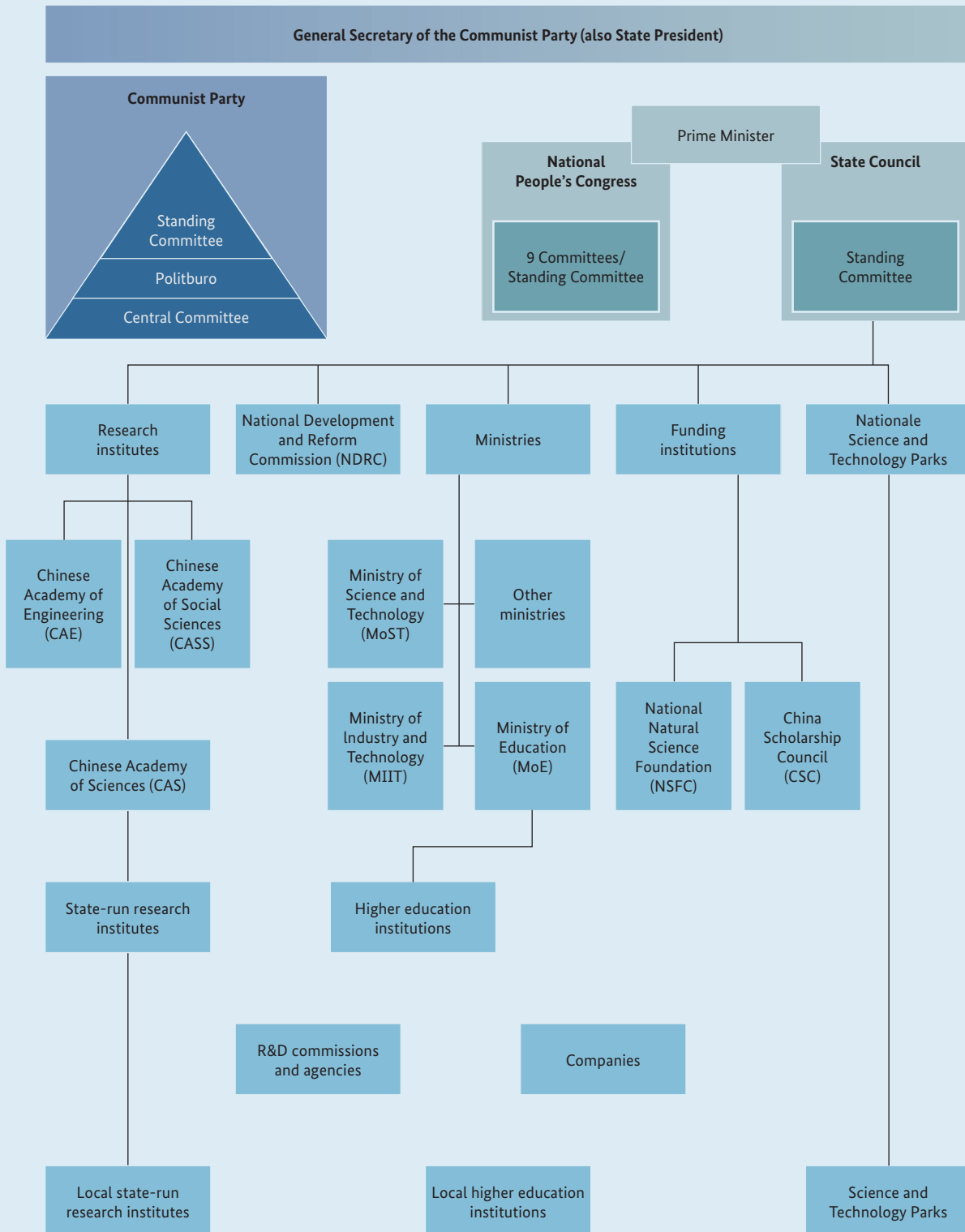
In accordance with directives issued by the State Council, the **Ministry of Science and Technology** (MoST) develops strategies and regulations for the implementation of national science and technology policy. Politically important projects and large-scale funding programmes are prepared by the MoST, then decided at higher level and finally implemented by the MoST. The **Ministry of Education** (MoE), as the highest education authority, exercises framework-setting powers for the structure and content of school education and tertiary education services. The **Ministry of Industry and Information Technology** (MIIT) is not only responsible for the implementation of national regulations concerning ICT, but also oversees financing for numerous infrastructure projects. The **National Development and Reform Commission** (NDRC) is largely responsible for the drafting of long-term plans and the Five-Year Plan for National Economic and Social Development and as such influences national research policy even though its powers have been limited in recent times.

The **Chinese Academy of Sciences** (CAS) is the national research institution for natural sciences. On the one hand it advises the government on all research-related issues and on the other hand its 124 institutes conduct public research activities. The **Chinese Academy of Social Sciences** (CASS), with its 80 research institutes and research centres, is the top academic research organisation in the social sciences and humanities sector. The **Chinese Academy of Engineering** (CAE) focuses on engineering and technology sciences. In contrast to the CAS and CASS, the CAE has no dedicated research

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<sup>13</sup> Apart from the Communist Party, China recognises eight other 'democratic parties'. These are involved in governing under the leadership of the Communist Party, and hold high-level political positions, as shown by the current research minister Wan Gang, who is a member of the Zhi-Gong Party.

Figure 4 Key stakeholders in the Chinese education and research system



Source: BMBF.



institutes of its own and instead acts for the most part as an adviser in the development of programmes and strategies for large-scale projects at national level.

The **National Natural Science Foundation** (NSFC) works in close cooperation with the MoST in developing fundamental guidelines and plans for basic research and manages the budget allocated to promote natural science and (applied) basic research. The **China Scholarship Council** (CSC) is subordinated to the MoE. Its primary responsibility is to support Chinese citizens wanting to study abroad and foreign citizens planning to study in China.

### 2.3 National plans, programmes and thematic priorities

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Many reforms in science and technology promotion as well as constant increases in R&D expenditure reflect the efforts of the Chinese government to promote research and innovation as a prerequisite for economic growth in China. Research and innovation policy is based on three national plans:

The **National Medium- and Long-Term Program for Science and Technology Development (2006–2020)** provides the framework for Chinese research and technology policy in the period up to 2020. Specific targets involve an increase in R&D expenditure to at least 2.5 percent of GDP, raising the R&D contribution to economic growth to at least 60 percent, reducing

dependence on foreign technology to below 30 percent and ranking among the world's top five nations in patents and citations.

The **12th Five-Year Plan** (2011–2015) sets out the goals for the National Medium- and Long-Term Program and describes measures and the enabling conditions required to promote research and technological innovation, and for the expansion of the innovation system and the science and technology infrastructure.

In addition to this, under the 12th Five-Year Plan, the **Development Plan for National Strategic Emerging Industries** (environmental technology, ICT, biotechnology, high-tech production, renewable energies, materials science and the automotive sector with a focus on electric mobility) was drafted in July 2012. By 2015, these seven industries are to generate eight percent of Chinese GDP and as much as 15 percent by 2020.

In addition to the plans already mentioned, the Chinese government has published a number of other thematic strategy papers which are having a major influence on research and innovation activity. These include the **Made in China 2025** Plan to develop a smart manufacturing industry and the Action Plan **Internet Plus**, which is designed to link mobile internet, cloud computing, big data, the internet of things and similar technologies with the modern manufacturing industry, and push online retail and online financing.

In research promotion, project-related funding under state-run research programmes<sup>14</sup> plays a key role. According to the most recent official figures, in 2012 some RMB 29.7 billion<sup>15</sup> (approximately EUR 3.6 billion) was spent on R&D programmes and another RMB 13.8 billion (approximately EUR 1.7 billion) on National Science and Technology Major Projects. This amount is largely distributed across programmes such as the **National High Technology R&D Program (863 Program)** to promote selected high-end technologies, the **R&D**

**Infrastructure and Facility Development Program** to expand the R&D infrastructure, the **National S&T Support Program** to concentrate resources in key technologies for the modernisation of industry and agriculture, and the **National Basic Research Program (973 Program)** for basic research in selected sectors. These programmes place priority on manufacturing and production technology, materials, ICT, environmental technology, renewable energies, and water and resources.

The Chinese research funding system has been subject to gradual reform since 2014. The aim is, by 2017, to place research funding in a standardised allocation system with just five funding programmes (for basic research, national major projects in science and technology, a national focus programme for R&D, a special programme for technological innovation, and a programme to develop the infrastructure and human resources). A national management platform, with a dedicated funding organisation, will be created to manage these programmes.

The Chinese government has also set up a number of programmes to make China an attractive research location for both domestic and international researchers, and to transform domestic higher education institutions into world-class, elite establishments (the latter via the **211 Program**, the **985 Program** and the **C9 League**, in which nine top universities in mainland China have formed an alliance). By mid-2013, the **Thousand Talents Program** launched in 2008, which offers attractive salaries, start-up packages and tax incentives, had attracted around 3,300 well-established academics and entrepreneurs with experience in other countries to move (back) to China.

The Top 200 in the 2015 Shanghai Academic Ranking of World Universities include seven Chinese universities (Beijing, Shanghai Jiao Tong, Tsinghua, Zhejiang, Fudan, Sun Yat-sen and the University of Science and Technology of China). These universities also lead two Chinese university rankings (China University Ranking Wu Shulian and the Netbig Ranking). A total of 32 Chinese universities are listed under the Top 500 in the Shanghai Ranking.

14 A list of all research and education programmes mentioned as of here is contained in Annex A. The abbreviations for some programmes refer to the year in which they were announced. For example, the 863 Program was launched in March 1986, the 973 Program in March 1997 and the 985 Program in May 1998. The 211 Program refers to the goal of naming 100 universities of excellence for the 21st Century.

15 For these and all other budget details, see MoST (2013): Annual Report of the State Programs of Science and Technology Development.



## 3. Current status of German-Chinese cooperation

### 3.1 BMBF

The Federal Republic of Germany and the People's Republic of China established diplomatic relations in 1972. The basis for research cooperation between the two countries is provided by the **Intergovernmental Agreement on Scientific and Technological Cooperation** of 9 October 1978. Since 1980, the **Joint S&T Commission** has met regularly with the MoST to agree joint projects and measures, and to discuss the framework conditions for cooperation. The work of the S&T Commission is supported by thematic **Steering Committees** (for example, environmental technologies/environment, geosciences, marine and polar research) which are responsible for the planning of cooperation activities for their respective areas.

In the education sector, regular consultations have been held with the MoE since 2004 in the form of a **Strategy Dialogue on Education Policy** (which replaced the Strategy Dialogue on Higher Education Policy in 2009). In addition since 2011, regular meetings have been held

by the Steering Group of the **German-Chinese Alliance for Vocational Education and Training**.

The first phase of German-Chinese cooperation in research and education in the 1980s primarily involved general exchange of information and experience, the organisation of events and mutual visits by specialist delegations to establish diplomatic relations (science diplomacy) and explore cooperation potential. This was followed in the 1990s by increasingly intensive project-based collaboration and cooperation between research institutes, for example through the establishment of joint partner groups and young scientist groups. The topics addressed were dominated by basic research in the natural sciences, as well as applied research in energy, raw materials and biotechnology. Since the turn of the millennium, project-based collaboration has further intensified and joint education institutions and courses of study have been established. Since 2011, the BMBF has supported the MoE by providing advice on the introduction of a new vocational education and training structure.

**Table 4 Overview of joint declarations of intent in education and research since 2011**

Occasion	Subject	Chinese partner ministry
1 <sup>st</sup> German-Chinese intergovernmental consultations, Berlin, 27/28 June 2011	Sino-German Life Science Platform	Ministry of Science and Technology (MoST)
	Sino-German Innovation Platform	MoST
	German-Chinese Research and Innovation Programme 'Clean Water'	MoST
	Promotion of comprehensive cooperation and establishment of a strategic partnership in higher education	Ministry of Education (MoE)
	German-Chinese Alliance for Vocational Education and Training	MoE
2 <sup>nd</sup> German-Chinese intergovernmental consultations, Beijing, 30 August 2012	Cooperation in LED (light-emitting diode) technology	MoST
	Cooperation in marine and polar research	State Oceanic Administration
Official visit by Chinese President Xi Jinping, Berlin, 28 March 2014	German-Chinese 'Clean Water' Innovation Centre	MoST
	Strengthening of strategic partnership and cooperation in education and research	MoE
3 <sup>rd</sup> German-Chinese intergovernmental consultations, Berlin, 10 October 2014	Cooperation in Science Year 2015 'City of the Future'	MoST
	Promotion of ongoing cooperation between German and Chinese universities in innovation-oriented research for the solution of global challenges	MoE
	Extension of the German-Chinese Alliance for Vocational Education and Training	MoE
High-level visit by BMBF, Beijing, 7 May 2015	Scientific and technological cooperation in the Mega Water Program for the treatment and control of water pollution in China	MoST

Source: BMBF.

Cooperation further intensified in subsequent years in the form of **German-Chinese intergovernmental consultations** which, following those in 2011 and 2012, were held for the third time in October 2014. China is one of the few countries with which Germany conducts intergovernmental consultations. Since 2011, the BMBF and its Chinese partner ministries have signed thirteen joint declarations, including ten during intergovernmental consultations.

The BMBF's cooperation with China currently focuses on activities in innovation research, clean water and environmental technologies, life sciences, marine and polar research, electric mobility, LED technologies, higher education, vocational education and training, and the exchange of students and scientists.



### Innovation Platform

During the 1st German-Chinese intergovernmental consultations in 2011, the BMBF and the MoST signed a Joint Declaration on the Establishment of a Sino-German Innovation Platform. Focal points for networking and discussion were cited as innovation research and policy, and strengthening innovation capabilities in the two countries. Leading German and Chinese scientists, institutions and companies are involved in the platform's development. Following three German-Chinese innovation conferences and ongoing contact between the stakeholders involved, the two sides have expressed the desire to intensify existing cooperation activities and build on mutually acquired knowledge of national innovation systems. It is planned to intensify the cooperation by conducting joint projects, broadening the participation of stakeholders and building a bridge to concrete technologies or cooperating in tackling today's global challenges.

### Clean Water

At the 1st German-Chinese intergovernmental consultations in 2011, the BMBF and the MoST agreed on the implementation of a German-Chinese Research and Innovation Programme 'Clean Water'. The aim is to foster collaboration between companies, research institutes and stakeholders in Germany and China in the search for solutions to urgent problems in China's water and wastewater sector. Implementation of the SEMI-ZENTRAL, WAYS, DELIGHT and HAPPY projects occurs under the BMBF International Partnerships for Sustainable Technologies and Services for Climate Protection and the Environment Programme (CLIENT). This work is supported by a joint project office (PROSAWA) located at Tongji University in Shanghai and by the German-Chinese 'Clean Water' Innovation Centre at the Zhangjiang Hi-Tech Park in Shanghai. The Innovation Centre houses the German Water Partnership comprising renowned German companies and research institutes. Germany also participates in China's Mega Water Program, with three research and innovation projects (SINOWATER, SIGN and Urban Catchments) which receive funding under the BMBF CLIENT Programme.



### Sino-German College for Applied Sciences in Shanghai

Established at Tongji University in 2004, the Sino-German College for Applied Sciences (Chinesisch-Deutsche Hochschule für Angewandte Wissenschaften, CDHAW) is sponsored by a consortium of 26 German universities of applied sciences. More than 800 Chinese students are currently undertaking four-year Bachelor's degree programmes in mechatronics, automotive technology (after-sales service), building technology and engineering management which were developed based on the study model and curriculum used in German universities of applied sciences. Around 80 percent of the students complete their studies with a dual degree from one of the German partner universities. German students have been able to study at the college and attain a dual Bachelor's degree since 2009. The university currently has some 105 German students, 83 of whom are aiming for a dual Bachelor's degree. The Sino-German Campus (Chinesisch-Deutscher Campus, CDC) at Tongji University, which is also funded by the BMBF, serves the mutual exchange of information and linking of the numerous German programmes and projects being conducted at Tongji University. The CDC promotes joint events and fosters contact with other Chinese organisations dealing with Germany (such as the German Studies Center at the University of Beijing and the German-Chinese Institute of Law, which has premises in Nanjing and Beijing). The Sino-German University (Chinesisch-Deutsche Hochschule, CDH) founded at Tongji University in March 2011 acts as the common roof for the CDHAW, the Sino-German College for Graduate Studies (Chinesisch-Deutsches Hochschulkolleg, CDHK) – which, in collaboration with German partner universities, offers Master's degrees in electrical engineering, mechanical engineering, automotive technology and economics – and the Sino-German Institute for Vocational Education and Training (Chinesisch-Deutsches Institut für Berufsbildung, CDIBB), with its vocational education-focused course of study at Master's degree level.

### Sino-German Life Science Platform

With the creation of a Sino-German Life Science Platform, the BMBF and the MoST agreed to intensify cooperation between the two countries at the 1st German-Chinese intergovernmental consultations in 2011. The platform is used to consolidate and develop existing collaborative activities in the life sciences sector. These activities have involved a German delegation to China and a German-Chinese workshop. The current aim is to develop a joint database, listing institutions and stakeholders from German and Chinese industry and science whose work focuses on the life sciences, and also to support industry-led consortium projects in biomaterials using the 2+2 model (a research institute or higher education institution and a company from each country).

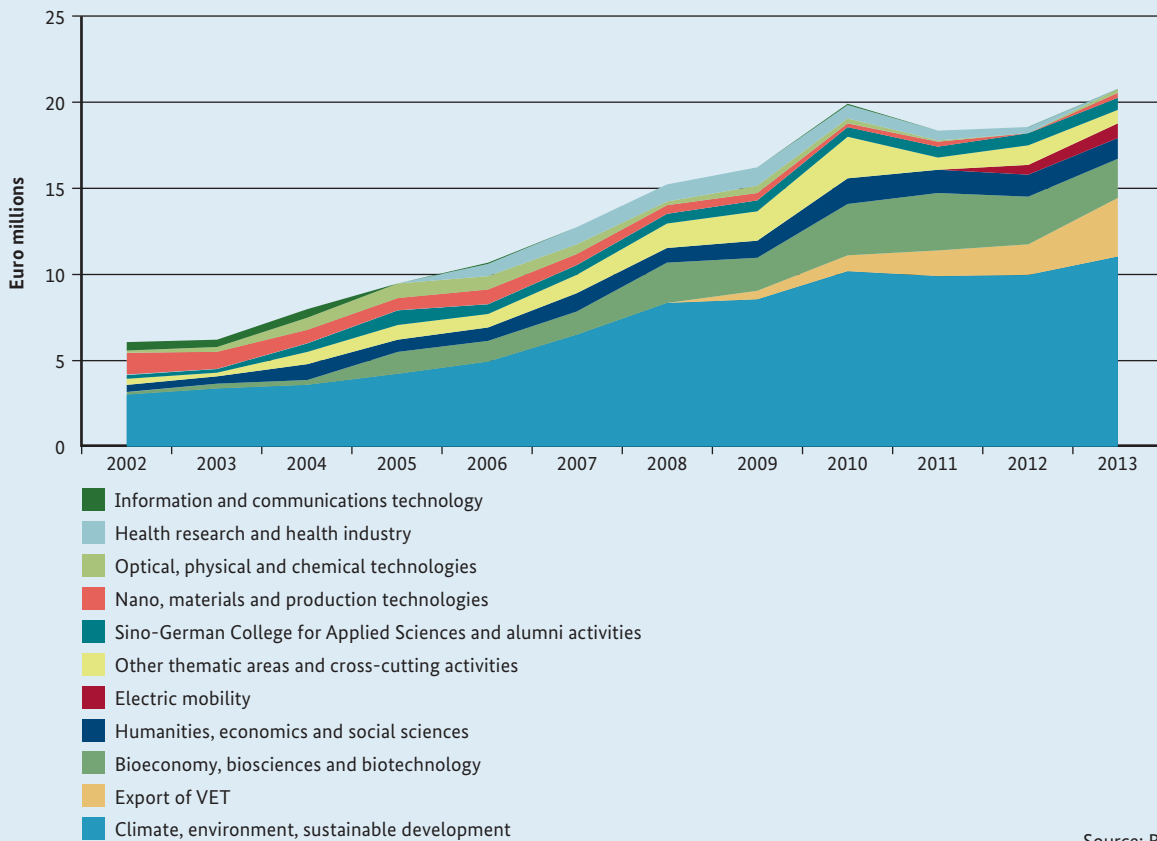


### Cooperation in Vocational Education and Training

School-based vocational education and training (VET) systems such as that in China have been under pressure to reform for some years. Global competition and economic systems that place greater focus on innovation call for new types of work organisation and training of skilled workers. In international cooperation on VET, Germany relies on the core principles of the dual system, such as learning on the job and acceptance of recognised national standards. Since the German-Chinese Alliance for Vocational Education and Training was founded in 2011, a firm cooperation partnership has developed between the BMBF and the MoE. The BMBF supports Chinese partners in government and industry in their efforts to reform the VET system and thereby meet demand for skilled workers, not least from German companies operating in China. The Chinese government has instructed regional administrations to develop their own platforms for cooperation between companies and education providers (such as vocational colleges) and to create the conditions needed to enable partnerships to evolve. For Germany to provide advice

regarding the development of a dual system, it requires a good understanding of the local stakeholders involved in VET and of how to build appropriate networks. This is one of the issues addressed by the BMBF-funded project VETnet (German chambers worldwide network for cooperative, work-based vocational education and training), which supports the creation of VET capacities at eleven German chamber of commerce offices worldwide, including in Shanghai. This helps create the structures in China that are vital in ensuring high-quality VET. The activities include German-Chinese staffed VET committees and VET examination committees. In addition, the German Federal Institute for Vocational Education and Training (BiBB) together with the German Office for International Cooperation in Vocational Education and Training (GOVET) fosters research and development in VET. With its International Marketing of Vocational Education (iMOVE) campaign and focus on promoting the export of VET from Germany, the BMBF supports German initial and continuing VET providers in their activities in China.

Figure 5 BMBF expenditure on cooperation with China for the period 2002–2013<sup>16</sup>



China is the country on which the BMBF expends the most funds for cooperation activities. From 2002 to 2013, BMBF funding for bilateral cooperation with China increased three-fold, from nearly EUR 7 million to approximately EUR 21 million. Of this amount, in 2013, more than half was spent on measures involving the areas of climate, environment and sustainability, followed by activities related to cooperation in vocational education and training, bioeconomy and biotechnology, the humanities and social sciences, and electric mobility.

At a meeting in Berlin at the end of March 2014, Chancellor Angela Merkel and President Xi Jinping announced a ‘mutually beneficial innovation partnership’

to enhance cooperation in the fields of urbanisation and industrialisation, transportation, electric mobility, energy, clean water and resource efficiency. The details were announced in the interministerial framework of action for German-Chinese cooperation ‘Shaping innovation together!’ at the third German-Chinese intergovernmental consultations on 10 October 2014 in Berlin.

### 3.2 Research, funding and intermediary organisations

International cooperation is now an integral part of everyday science and research, and cooperation between German research institutes and Chinese partners has intensified in recent years. All of the big German research institutions collaborate with Chinese higher education institutions, research institutes and companies by means of various programmes and on a wide range of topics.

<sup>16</sup> Fig. 5 shows the funds provided directly by BMBF and its project management agencies. This does not include BMBF funding which is managed by the German Academic Exchange Service (DAAD) and the Alexander von Humboldt Foundation (AvH) in connection with international programmes that do not have a concrete target country but also fund cooperation projects with China.

The estimated expenditure incurred by German research, funding and intermediary institutions in their cooperation with China has grown considerably in recent years. While spending in 2006 amounted to EUR 26.3 million, it had risen to EUR 40.7 million in 2010 and to EUR 46.5 million in 2014.<sup>17</sup>

These cooperation activities are largely defined by the respective roles and missions of the German research organisations within the research system, their respective internationalisation strategies and their overarching goals and objectives. Depending on the reason for the cooperation, these can include not only the primary research goals, but other objectives such as strengthening Germany's image as a research location (by securing its international compatibility) and direct and indirect benefits to German industry.

The **Max Planck Society** (MPG) has collaborated with the CAS since 1974. Particularly noteworthy in this regard are the CAS-MPG Partner Institute for Computational Biology in Shanghai, the establishment of independent young researcher groups in China in line with the MPG model (12 groups since 1995) and the Max Planck partner groups (over 30 established since 1999) run by young Chinese scientists who prior to founding the groups had held a post-graduate position at a Max Planck institute for at least one year. The **Helmholtz Association of German Research Centres** (HGF) has had an office in Beijing for more than ten years. Apart from the cooperation activities of individual Helmholtz institutes, the Helmholtz-CAS Joint Research Groups should also be highlighted. More than a third of the almost 90 institutes belonging to the **Leibniz Association** have established relations with China; some institutes have maintained a local presence with their Chinese partners for many years. The **Fraunhofer-Gesellschaft** (FhG) has been represented in Beijing since as far back as 1999. This presence forms a bridge to Chinese partners such as the CAS and the Chinese Academy of Engineering. The FhG also cooperates with a large number of universities, including Tsinghua, Tongji and Shanghai Jiao Tong, and with institutes of the Beijing Academy of Science and Technology, the Shanghai Academy of



Science and Technology, and the Shandong Academy of Sciences. In 2007, the FhG and the CAS established a jointly funded programme for Chinese postgraduate students. The aim of all FhG projects in China is to work with excellent research partners on topics which in the light of the country's dynamic economic growth and rapid urbanisation require qualitative and quantitative technological solutions. Fields of interest include environmental technologies, infrastructure, transportation and energy-efficient buildings in megacities, and public health. The **German National Academy of Sciences Leopoldina** maintains contact with China in the form of mutual delegation visits and symposiums held with Chinese partners on varying topics in both Germany and China.

<sup>17</sup> Estimates based on figures provided by the MPG, the HGF, the FhG, the DFG, the AvH and the DAAD. In the case of the AvH and the DAAD, figures include funding managed on behalf of the BMBF under international programmes involving cooperation with China.

## Max Planck Society

### ***CAS-MPG Partner Institute for Computational Biology***

Founded in 2005 by the CAS in conjunction with the Shanghai Institute for Biological Sciences, the CAS-MPG Partner Institute for Computational Biology (PICB) is a legal and administrative arm of the CAS, but is nonetheless a typical Max Planck Institute in terms of its foundation and appointment processes, structure and management. The MPG concentrates its cooperation activities on programmes to promote young scientists (Max Planck Research Groups/International Max Planck Research School) and MPG-PICB projects. Almost all directors of the PICB are also connected with the MPG via Max Planck Fellow agreements and are funded accordingly. In addition, there are currently four Max Planck research groups. The International Scientific Council, which conducted an in-depth audit of the PICB for the fourth time in 2014, reported that the institute performed excellent research work.

### ***Exploratory Round Table Conferences at the Shanghai Institute for Advanced Studies***

The Exploratory Round Table Conferences (ERTC) focus on topics whose respective scientific communities are starting to emerge worldwide. The MPG and the CAS serve as the host for a small circle of leading international experts. The conferences are held as closed-door events and attendance is limited to around 30 scientists who are nominated by the MPG and the CAS. They provide researchers at the MPG and the CAS with the opportunity to explore promising new research fields and assess their potential. The outcomes from the ERTC are formulated as a set of concrete recommendations to the MPG and CAS presidents. Topics explored to date include synthetic biology (2010), quantum information science (2011), space-based research (2012), electro-chemistry (2013) and personalised medicine (2014). The topic for the conference scheduled for autumn 2015 is big data in the natural sciences and humanities.

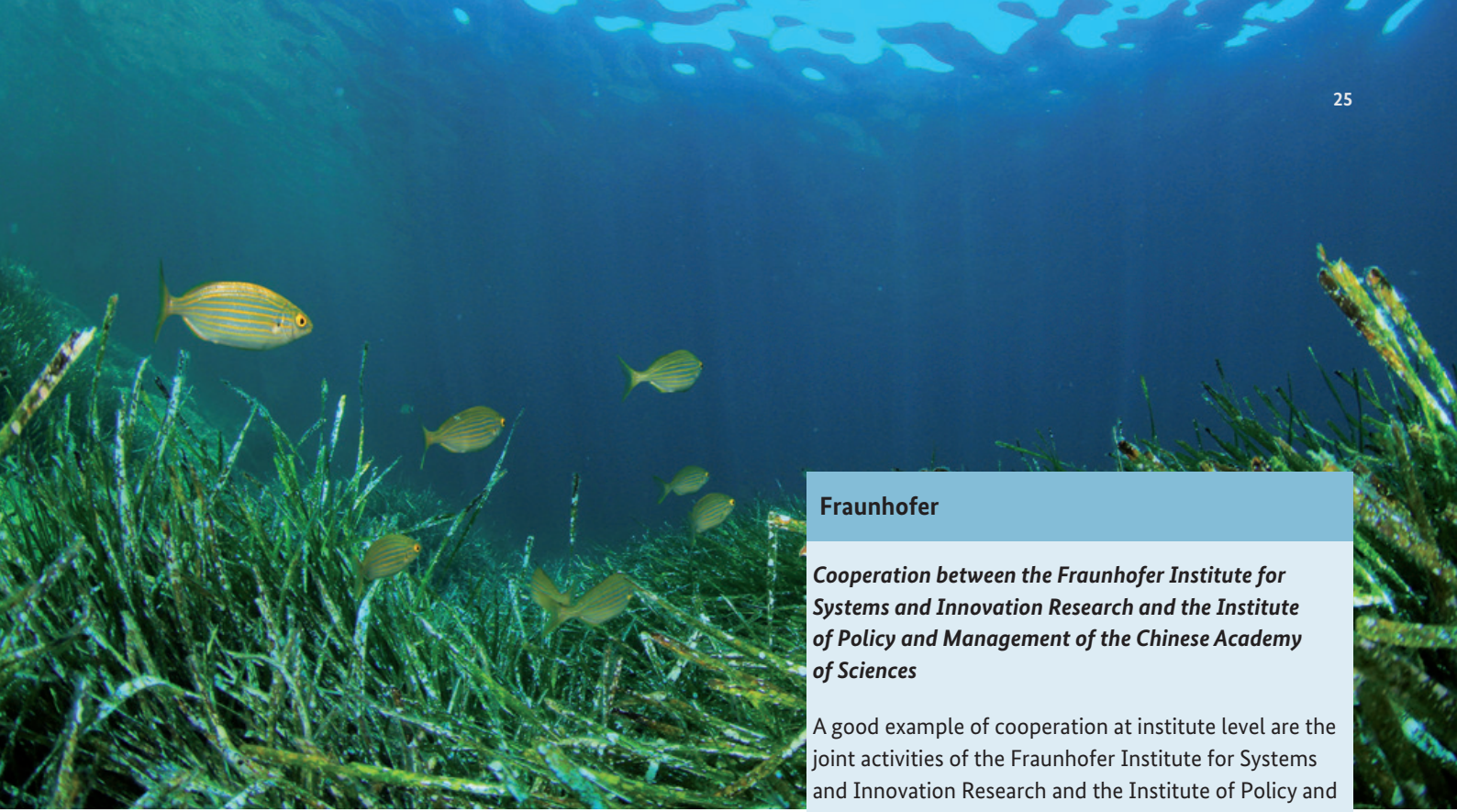
## Helmholtz Association

### ***Research Centre for Environmental Information Science***

In March 2014, the opening of the Research Centre for Environmental Information Science (RCEIS) saw the birth of a German-Chinese centre of excellence for earth systems monitoring and modelling. Coordinated by the Helmholtz Centre for Environmental Research and CAS, this research network concentrates on the topics of water, soil and air pollution, with the focal point of its work being the modelling of environmental information systems along large rivers and lakes in China. On the HGF side, apart from the Helmholtz Centre for Environmental Research (which has a coordinating role), the Research Centre Jülich, the Karlsruhe Institute of Technology and the German Aerospace Centre are also involved. The lead partner on the Chinese side is the CAS Institute for Geographical Sciences and Natural Resources Research. The RCEIS pilot project is one of two Helmholtz international research networks. The aim of this new instrument is to support the establishment and further development of joint research ventures between Helmholtz centres and strategic cooperation partners abroad.

### ***Helmholtz-CAS Joint Research Groups***

The long-standing successful cooperation between the Helmholtz Association and Chinese research institutes was reinforced in 2012 with the Helmholtz CAS Joint Research Groups programme to promote joint research groups in various fields for a period of three years. Since then, three joint calls for proposals have been announced, each involving five joint research groups. For each of the groups, the HGF provides funding from its impulse and networking fund in amounts ranging between EUR 80,000 and EUR 120,000 per year. CAS contributes around EUR 35,000 annually.



### Leibniz Association

#### ***Bilateral ecosystem research on China's tropical coasts***

Coordinated by the Leibniz Centre for Tropical Marine Ecology in Bremen, the German-Chinese joint project LANCET investigated interactions between land and the oceans on the tropical island of Hainan in the South China Sea. There is evidence that the status of the ecosystem and the economic potential of the coastal region is at risk from human intervention and extreme weather events. Given the success of the work conducted by LANCET and the scope of environmental problems faced on Hainan's coasts, the follow-up project ECOLOC was launched to take an in-depth look at the damage aquaculture causes to seagrass meadows and coral reefs, and the potential impact from sea level rise.

#### ***Status of the marine environment in the Beibu Gulf in the South China Sea***

The BEIBU project involved cooperation between scientists from the Leibniz Institute for Baltic Sea Research in Warnemünde, the Leibniz Centre for Tropical Marine Ecology in Bremen and those from the Guangzhou Marine Geological Survey and the Guangxi Mangrove Research Center in Beihai. The aim of the project was to assess biogeochemical flows and changes to them caused by natural occurrences (e.g. climate variations) and anthropogenic influences (such as pollution and coastal use) in the Beibu Gulf.

### Fraunhofer

#### ***Cooperation between the Fraunhofer Institute for Systems and Innovation Research and the Institute of Policy and Management of the Chinese Academy of Sciences***

A good example of cooperation at institute level are the joint activities of the Fraunhofer Institute for Systems and Innovation Research and the Institute of Policy and Management of the CAS in the fields of future technologies, innovation policy, indicator-based analysis of national and regional innovation systems, and entrepreneurial innovation research. In May 2013, this relationship was intensified with the establishment of the Joint Center for Innovation Research, which has premises in Beijing and Karlsruhe. The Joint Center is staffed by researchers from the respective partner institutes who are seconded on long-term assignments and as part of rotating, project-related research teams.

#### ***Project on Small Hydropower Plants: Assessment of Climate Protection Potential and Improvement by Smart Technologies***

By building small-scale hydropower plants, China aims to reduce the burning of wood in private households and create a climate-compatible energy infrastructure. However, use of hydro-electricity impacts water ecology, waterflow, socio-economic structures and aquatic ecosystems. Funded by the BMBF, the research project Small Hydropower Plants: Assessment of Climate Protection Potential and Improvement by Smart Technologies (HAPPI) is thus designed to develop an evaluation tool to be used in planning, construction and operation of small-scale hydropower plants. The Institute for Applied Information Technology at the Fraunhofer Institute of Optics, System Technologies and Image Exploitation, the Fraunhofer Institute for Systems and Innovation Research, the University of Kassel and three German SMEs cooperate with Chinese partners such as the China Institute of Water Resources and Hydraulic Power Research.

## German National Academy of Sciences Leopoldina

### *Cooperation with Chinese partners in various dialogue processes*

The Leopoldina has long-standing relations with Chinese academies, especially with the CAS (since 2005) and the Chinese Academy of Engineering (since 2011). To date, a range of German-Chinese symposiums have been held, largely on natural science and technological topics such as nanotechnology and chemistry. Regular contact with Chinese researchers occurs via the Leopoldina Study Centre. This also includes topics involving the humanities and social sciences, such as in a joint project to assess knowledge transfer and modernisation processes between Europe and East Asia. Bilateral contact is also maintained on a regular basis in the form of delegation visits (especially those involving Chinese partners visiting the Leopoldina headquarters in Halle) during which discussion often focuses on opportunities and formats for national policy consultation. Cooperation with Chinese partners also occurs under the auspices of international academy networks like the

InterAcademy Partnership, which also focus largely on policy consultation.

### *Leopoldina membership for Chinese scientists*

High-ranking Chinese scientists are increasingly being elected as Leopoldina members. Given the intensifying scientific links between Germany and China, and the growing importance of Chinese research, it can be expected that Chinese membership of the Leopoldina will continue to grow. The seven current Chinese members work in the fields of technical sciences, physics, biology, medicine and geosciences. Their election is based on the criterion of scientific excellence, although Chinese members in particular are also influential in terms of science and research policy. Examples include Li Jiayang, president of the Chinese Academy of Agricultural Sciences, and Lu Yongxiang, former president of the CAS and former vice-president of the Third World Academy of Sciences.



The **German Academic Exchange Service** (DAAD) had restored its relations with China back in the early 1970s. In 2014, it facilitated 3,276 scholarships which enabled students and lecturers (1,565 from Germany and 1,711 from China) to travel to the respective partner country. The broad scope of DAAD support ranges from individual grants (12-month stays or shorter, research stays and work placements) to young scientist research groups, courses of study at German higher education institutions and strategic partnerships between German and Chinese universities. The **German Research Foundation** (DFG) and the NSFC, which started their cooperation back in 1988, jointly run the Sino-German Centre for Research Promotion in Beijing. For the **Alexander von Humboldt Foundation** (AvH), China is one of the most important partner countries. When looking at the total number of scientists sponsored by the AvH, China ranks third worldwide, with 1,951 research scholarships and prize winners.



## German Academic Exchange Service

### ***Chinese-German Technical Faculty at the Qingdao University of Science and Technology***

The Chinese-German Technical Faculty is one of the first transnational education projects launched under the programme 'German higher education projects abroad/Transnational education'. The University of Paderborn and the Qingdao University of Science and Technology jointly established the faculty, initially for mechanical engineering and since 2006 also for chemistry. In the meantime, the University of Siegen (electrical engineering) and the Koblenz University of Applied Sciences (measuring and sensor technology) also offer courses at the Chinese-German Technical Faculty, albeit on a smaller scale. Currently there are some 1,000 Chinese students enrolled there. In the first year, students receive intensive German lessons, study their chosen discipline and also receive parallel tuition in technical German and communication. Upon completing their basic courses, up to 50 of the top students in both their subject and the German language have the chance to relocate to Paderborn. The Chinese students receive a Bachelor's degree from Paderborn University. A key component of the Bachelor course in mechanical engineering is an internship of at least 12 weeks at a German company. In 2012, the Mechanical Engineering in China project (mb-cn) opened the door for German students to spend part of their studies in Qingdao and obtain an initial introduction to the Chinese language and culture. As a rule, the students write their research papers under the

supervision of a German-speaking lecturer. Some also serve as student tutors. In 2013, the programme was additionally opened to students of industrial engineering, enabling them to study in China for a period of several months.

### ***Degree course in International Logistics Management at Hefei University – LOGinCHINA***

With LOGinCHINA, the DAAD (as part of its programme 'German higher education projects abroad/Transnational education') supports the Osnabrück University of Applied Sciences in establishing its courses in international logistics management at Hefei University. In the third semester of the Bachelor's degree programme, most of the lectures are given in German by staff from the Osnabrück University of Applied Sciences. In their third year, students can opt for a semester abroad at the University of Osnabrück. Some 170 Chinese students registered for the course in 2013/2014. The project shows the extent to which the potential of German universities of applied sciences can be used to support China's tertiary education institutions in their efforts to combine scientific theory with practice. The programme thus serves in offering Chinese students practice-oriented training in logistics management and in giving them intercultural skills which can later be of benefit to German companies operating in China.



## German Research Foundation

### *Sino-German Centre for Research Promotion*

In 2000, the DFG opened the Sino-German Centre for Research Promotion in Beijing as a joint venture with the NSFC. It was the DFG's first international representation. The Centre is financed in equal amounts by the two organisations and operates its own funding programmes and budget (e.g. for symposiums, research projects and summer schools, and to finance young researcher group leaders from Germany to visit China). Since 2004 one of its unique activities is the Lindau Programme, which gives selected postgraduates from the fields of physics, chemistry, medicine, physiology and economics the opportunity to take part in thematic Nobel prize winner conferences in Lindau, with a subsequent one-week trip to visit leading German research institutes in their respective fields.

### *German-Chinese Collaborative Research Centres/ Transregio Programme*

One particular example of the DFG's cooperation with China involves the German-Chinese Collaborative Research Centres/Transregios, which have been funded jointly with the NSFC since 2005. These are similar to traditional collaborative research centres, however in contrast to the traditional centres, they allow up to three locations of which one or two may be in another country. There are a number of German-Chinese collaborative research centres/Transregios currently being funded, which are investigating such topics as molecular assemblies and their technological potential, the interaction between viruses and cells in the immune system in the case of persistent viral infections, and symmetries and structure formation in quantum chromodynamics.

## Alexander von Humboldt Foundation

### *'Humboldtians' as ambassadors of German cooperation with China*

China is one of the key partner countries for the Alexander von Humboldt Foundation (AvH). Not only is one in seven applications the AvH receives from China, but Chinese applicants enjoy above-average success in being selected. In 2014, China received the most approvals in the Humboldt Research Fellowship Programme. Apart from 'ambassadorial' researchers who work on a voluntary basis, many Humboldtians work in top positions and serve as facilitators. They are part of a self-supporting network in China – one that harbours huge science policy potential. Through individual grants from the AvH, Humboldtians themselves serve as shining examples of German cooperation with China. Professor Wang Enge, President of Beijing University, is an AvH fellow from China. Professor Lu Yongxiang, former President of the CAS, is also a Humboldtian. He initiated the strategic partnership between the AvH and the CAS. There are currently some 1,400 Humboldtians in China (some 30 percent of them at CAS institutes).

In the course of intensive research collaboration, **higher education institutions** in Germany have placed their relationships with Chinese partners on longer-term foundations. Building on contacts maintained by individual scientists, increasingly structured forms of cooperation are emerging in research and education. According to the Higher Education Compass published by the German Rectors' Conference (HRK), more than 1,100 cooperation activities are currently taking place between German and Chinese higher education institutions.

#### German Rectors' Conference

##### *Joint study programmes of German and Chinese higher education institutions*

China is a key cooperation partner for German higher education institutions in Asia. The structured study programmes and dual qualification options that are jointly developed and offered by Chinese and German higher education institutions play a prominent role. These activities often arise from the basis of trust which develops from long-term collaborative relations between German and Chinese higher education institutions. Many of the programmes, which were largely developed in a bottom-up approach at the initiative of committed professors and lecturers, have since become real success stories. With the joint pre-selection of students and the subject-related and social support services on offer, these programmes ensure a student's success within a reasonable period of time. Chinese and German graduates of joint study programmes also have exceptionally good chances on the labour market. Many of the programmes are thus so popular that they have become self-sustaining, including financially. And as they tend to be particularly innovative, they boost the image of the higher education institutions involved. In 2005, to foster the positive trend and communicate best-practice models at national and international level, the German Rectors' Conference used the findings of a study to develop a set of recommendations for the development of joint German-Chinese study programmes.

### 3.3 European Union

Diplomatic relations between the European Union (EU) and China have existed since 1975. The basis for European-Chinese cooperation in research, technology and innovation is provided by the **Agreement for Scientific and Technological Cooperation** from 1998. A joint declaration on the high-level Innovation Cooperation Dialogue was signed by the EU and the Chinese research minister Wan Gang in 2012. The status and policy priorities of research cooperation are reviewed annually at meetings of the Joint Steering Committee on Science and Technology (most recently in June 2014). Based on regular policy dialogue with China, the EU published a Roadmap for EU-China Cooperation in Research and Innovation in September 2014.

In the past five years, the EU Directorate-General for Research and Innovation has launched a number of bilateral activities with Chinese partners. These include an agreement with the NSFC on the implementation of joint calls for proposals and a declaration on cooperation in the renewable energies sector. Current cooperation activities focus on food, agriculture and biotechnology (a respective declaration of intent was signed with the Chinese Academy of Agricultural Sciences in November 2013) and also on sustainable urbanisation including the fields energy, environment, transportation, ICT and social sciences. Aerospace cooperation based on a collaboration with the Chinese Ministry of Industry and Information Technology has been intensified through a coordinated call for proposals under the EU's Horizon 2020 framework programmes in 2014/2015.

On the occasion of the 16th EU-China Summit in November 2013, an **EU-China 2020 Strategic Agenda for Cooperation** was published in which a section on research, technology and innovation announced intensified cooperation (in the form of joint calls for proposals and the opening of existing programmes to scientists from the other side) in the fields of food, agriculture and biotechnology, sustainable urbanisation, aviation, water, health and ICT.

At the 17th EU-China Summit on 29 June 2015, the two sides spoke out in favour of intensified cooperation in research and innovation, in protecting intellectual property rights and closer cooperation between the NSFC and the European Research Council in the exchange of scientists and researchers.

Since 1998, Chinese research institutes have been able to participate in calls for proposals of the EU research framework programmes. Under the 7th Research Framework Programme (2007–2013), Chinese research institutes and companies participated more than 380 times in over 270 projects (of which about 170 also involved German partners). Thus, after the US and Russia, China was one of the most important partner countries in the 7th Research Framework Programme. In addition, some 880 Chinese scientists were involved in Marie Skłodowska Curie actions for improved mobility. Under the framework programmes, the links between EU scientists and Chinese partners have also been promoted through a number of non-topic-specific transversal projects.



In past framework programmes, China was an ‘International Cooperation Partner Country’, allowing Chinese partners participating in EU projects to receive direct EU funding. China remains a key partner country under Horizon 2020. Chinese scientists and companies can take part in almost all calls for proposals as equal partners and establish research teams with partners from the EU. However, as for partners from other industrialised countries and emerging economies, automatic funding from the Horizon 2020 budget is no longer possible for Chinese project partners. Chinese partners must thus finance their participation in EU projects through other sources.

Under Horizon 2020, several calls for proposals, especially in the fields of food, agriculture, biotechnology, water, energy, ICT, nanotechnology and aerospace and polar research, will be directed towards Chinese participation. The Horizon 2020 work programme 2014/2015 contained 15 research areas with a special focus on cooperation with China. EU-China cooperation also occurs under the Euratom Treaty on peaceful use of nuclear energy in fusion and fission research and in the institutes of the Joint Research Centre of the European Commission. To increase European scientists’ mobility to China, the Directorate-General for International Cooperation and Development issued a call for proposals for the EU-China Research and Innovation Partnership in April 2014.

To underline the cooperation with China in political terms, a special China initiative was launched in 2011 as part of the joint **Strategic Forum for International S&T Cooperation** (SFIC) of the EU Member States<sup>18</sup> and the European Commission. Workshops were organised to discuss best practices and the legal basis for R&D cooperation. In addition, a Strategic Research and Innovation Agenda was drafted, setting out the four priority research topics of renewable energies and green technologies, urbanisation, health and ICT along with the horizontal topics of innovation research, mobility and framework conditions for R&D cooperation. With regard to China, SFIC currently focuses on urbanisation, thus supporting the ‘Joint Programming Initiative Urban Europe’.

18 See Annex B for a description of bilateral China activities conducted by selected EU Member States.



## 4. Strategic goals, guiding principles and points for consideration

In its further cooperation with China in research, science and education, the BMBF focuses on the following strategic goals and guiding principles that form an action-focused framework for future cooperation.

### 4.1 Goals – What would we like to achieve by cooperation?

In international cooperation, the BMBF's overarching strategic goal is to strengthen German science and research. Regarding the cooperation with China, three of the four target areas of the Strategy of the Federal Government for the Internationalisation of Science and Research of 2008 are of particular importance: strengthening research cooperation with global leaders, exploiting international innovation potential and assuming international responsibility in mastering global challenges. The training of skilled workers can be seen as an additional target area.

In its future China policy, the BMBF will:

- support German stakeholders in science, research and industry in their **cooperation activities with China** (research value creation), in establishing innovation partnerships and in **opening up markets and business sectors** (industrial value creation)
- improve **German students' and scientists' access to top Chinese higher education and research institutions** in a targeted move to enhance both scientific expertise and intercultural skills – this also applies to joint research and learning with Chinese partners in Germany
- promote the **internationalisation of teaching and research at German higher education institutions through strategically designed and structured cooperation activities of German and Chinese higher education institutions**
- create a **broader, publicly accessible knowledge base on the Chinese education, research and innovation system** and on China in general to foster **greater China expertise in Germany**



- work to achieve **favourable conditions for China-related engagement of German science, research and industry** (both in Germany and especially in China)
- work with Chinese partners to **master global challenges** and support **sustainable, resource-efficient, environment-friendly and socially acceptable development**

These goals will guide the BMBF's future cooperation with China at policy-level in the knowledge triangle of education, research and innovation (including German research institutes, funding and intermediary organisations, higher education institutions, (vocational) education providers, and industry).

In particular, the BMBF will take a pro-active approach to improving the framework conditions for coopera-

tion with China. For example, when developing new research cooperation activities, these should from the outset include conditions for subsequent use of R&D results on the Chinese market.

## 4.2 Guiding principles – How do we want to cooperate?

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The BMBF bases its future cooperation with China on the following guiding principles, which are designed to secure the long-term success of international cooperation activities and to ensure that the expectations of both sides are met:

- **Representation of own interests while taking account of mutual added value:** in cooperating with

China, the interests of German higher education institutions, non-university research institutes, and companies must be actively represented. However, bilateral cooperation can only be successful if there are measurable benefits when compared to non-cooperation. In international research collaborations, this mutual added value is created in particular when the activities of the partners complement one another.

- **Continuity and reliability:** successful cooperation must be shaped by continuity and reliability on both sides. These do not necessarily come about by themselves, but must instead be developed through personal contacts. Trust and an understanding of cultural differences form the basis for long-term collaboration.
- **Transparency and openness:** cooperation must be based on the greatest possible transparency and openness on both sides. This includes exchanging the background information needed to develop and implement joint activities, transparency in how research results come about and unhindered access to relevant research data and markets. When conducting joint funding programmes for research cooperation, openness is necessary regarding the application and selection processes, the evaluation procedure and funding decisions.
- **Involvement of relevant stakeholders on both sides:** for a results-based, sustainable cooperation, all relevant actors must be involved and their standpoints considered. On the German side, this means bringing all the necessary stakeholders together, especially in industry and applications-related areas. Existing platforms such as the National Platform for Electric Mobility and the National Platform for Industry 4.0 bring experts from industry, science, government, the trade unions and industry associations together for strategic dialogue and can be used in opinion-forming regarding cooperation with China. On the Chinese side, depending on the topics involved and where otherwise appropriate, the BMBF aims to involve additional ministries and institutions (alongside the BMBF's usual partners, the MoST and MoE) as well as relevant actors at provincial and local level.
- **Coherence with activities at national and EU level:** the China-specific activities conducted by various German stakeholders (ministries at federal and

*Land* [state] level, research, funding and intermediary institutions, higher education institutions, and companies) should complement each other in a meaningful way. To ensure that this is the case, regular exchange of information and experience must be guaranteed. At the same time there is also a need to shape the development of China-focused activities at EU level (policy initiatives such as under the Strategy Forum for International S&T cooperation [SFIC], calls for proposals under Horizon 2020, etc.) and with other international organisations (OECD and UNESCO).

- **Research integrity and good scientific practice:** in all types of research cooperation, all stakeholders (at policymaking and institutional level, such as research institutes and funding organisations, and individual scientists) must follow the basic principles and rules of good scientific practice. This involves, for example, research work in general, scientific publications and authorship, mentoring and support of young researchers, and also the evaluation and selection criteria and processes, and expert evaluation activities. Both German and international stakeholders<sup>19</sup> have published recommendations and codes of conduct for good scientific practice.

### 4.3 SWOT analysis

For optimal development of future cooperation with China, it is necessary to analyse the strengths and weaknesses of the Chinese research and education landscape, and to define the resulting opportunities and risks of such cooperation for Germany. In such analysis, it is assumed that in international cooperation, knowledge of the strengths and weaknesses of the cooperation partner is just as important as knowing one's own strengths and weaknesses. The following SWOT analysis (analysis of Strengths, Weaknesses, Opportunities and Threats) thus focuses primarily on the opportunities and risks of cooperation for German science, research and industry based on China's strengths and weaknesses.

<sup>19</sup> See, for example, publications by the DFG (2013), the MPG (2009), the European Science Foundation and the Global Research Council (2012). The CAS also addressed the issue in its May 2014 bulletin.

**Table 5 SWOT analysis of cooperation with China**

Strengths of China	Weaknesses of China
<ul style="list-style-type: none"> <li>• Strong economic growth sustained over many years (more than 9% p.a. from 2002 to 2011, approx. 8% since)</li> <li>• Market size gives China huge purchasing power</li> <li>• Politically driven ‘innovation initiative’ with focus on innovative industry</li> <li>• High spending on education and research</li> <li>• Dynamic economic and social environment open to new technologies, products and services</li> <li>• Ability to adapt existing technologies very quickly to local needs (rapid adaptation and imitation)</li> <li>• Growing scientific output (rising numbers of patent applications and publications)</li> <li>• Political will to address social challenges and megatrends (urbanisation, demographic change, environmental pollution, modernisation of farming, healthcare, etc.)</li> <li>• Some excellent universities and research institutions with modern laboratories</li> <li>• Large pool of undergraduates, graduates and (young) scientists, with emphasis on natural and engineering science</li> <li>• Focus on technology disciplines (engineering science, nanotechnology, ICT, chemistry, electric mobility, renewable energies and materials science)</li> </ul>	<ul style="list-style-type: none"> <li>• Strong top-down control of economic and research policy (with qualitative, quantitative and time-bound targets)</li> <li>• Government requirements curb academic freedom</li> <li>• Many branches of industry dominated by state-owned enterprises</li> <li>• Overlapping powers (between Communist Party, central, regional and local government, and various ministries)</li> <li>• In some cases (still) heavily dependent on import and transfer of technology, little independent innovation, lack of cooperation between industry and research</li> <li>• Skewed incentive systems for scientists, e.g. pressure to patent and publish often leads to low quality</li> <li>• (Long-term) brain drain with top graduates and scientists moving abroad</li> <li>• Few systemic approaches, e.g. in environmental and climate research</li> <li>• Lack of focus on basic research</li> <li>• Very little creative thinking taught at universities</li> <li>• Social sciences and humanities have second-rate status and are in some cases still subject to political influence</li> <li>• Decisions to fund research projects made at administrative/institutional level and not by independent peer review</li> <li>• Relative scarcity of well-trained workers for industry and limited willingness of Chinese companies to provide training</li> <li>• Vocational and higher education lack practical relevance and in some cases quality assurance</li> <li>• Civil society absent (or only nascent), making stakeholder dialogue difficult</li> </ul>
Opportunities for Germany	Threats for Germany
<ul style="list-style-type: none"> <li>• China’s size, huge population and emerging middle class offer huge development opportunities for German industry (opening up of new markets, China as a testing ground)</li> <li>• Strong demand for green technologies and for technologies adapted to Chinese needs (most of all in energy, water, transport and recycling) due to ongoing urbanisation and environmental pollution</li> <li>• Opportunity for finding joint solutions to global challenges</li> <li>• Strong interest in technology and products from Germany</li> <li>• Cooperation can be planned on a medium- to long-term basis (due to national multiannual plans and programmes)</li> <li>• Access to in some cases outstandingly well-appointed research infrastructures, unique research locations and extreme regions</li> <li>• Increasing involvement of China in international standardisation committees, creating opportunities for joint standard setting</li> <li>• China as a gateway to other Asian markets</li> <li>• Opportunities for advisory services to support the current restructuring of the Chinese research funding and vocational education and training systems</li> <li>• Good market opportunities for German vocational education and training providers</li> <li>• The affinity towards Germany of many policymakers, researchers and scientists (often due to periods of study or research in Germany)</li> <li>• Great openness to cooperation, including in higher education</li> </ul>	<ul style="list-style-type: none"> <li>• Forced technology transfer and one-way knowledge transfer</li> <li>• Unfair conditions of competition (e.g. regarding export duties/taxes/quotas, enforced joint ventures in certain important economic sectors)</li> <li>• Unclear framework conditions for research cooperation (e.g. regarding IPR; problems when importing metrology equipment/exporting samples and obtaining licenses and approvals)</li> <li>• Lack of legal certainty regarding use of encryption technologies</li> <li>• Insufficient transparency and reliability of political decisions due to overlapping responsibilities</li> <li>• In some cases difficulties for foreign researchers regarding access to and processing of information</li> <li>• Differences in research cultures (academic freedom versus industry-oriented top-down agenda setting)</li> <li>• Low level of knowledge in Germany (most of all in SMEs and higher education institutions) regarding capacity and potential of Chinese research partners, the Chinese market and the legal framework in China</li> <li>• Linguistic and intercultural problems due to lack of China expertise in Germany</li> </ul>

Source: BMBF.

### Strengths of the Chinese research and science system

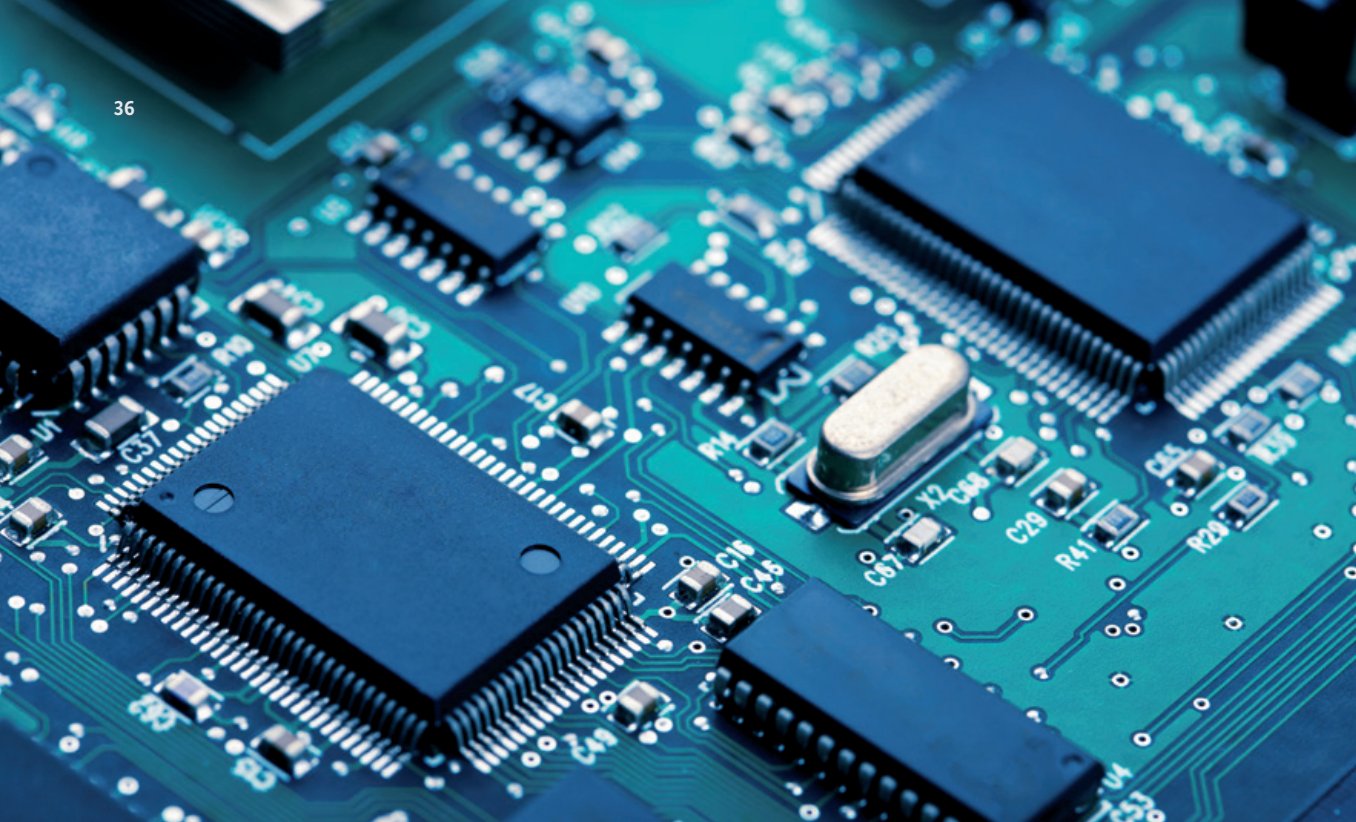
Due to the huge economic growth seen in recent years and the purchasing power that is closely attached to its market size, China has become an influential economic power. Thanks to the policy-driven ‘innovation initiative’, the Chinese science system has also developed apace in recent decades. The Chinese government has steadily increased its research expenditure and it can be expected that rather than declining, the research budget will further increase. China is extremely quick to copy existing technologies (imitation) or adapt them to local needs (adaptive innovation). This strength is what drives the quantitative success of publications and patents that are published and registered by Chinese scientists. For the past few years, attention has been given to generating innovations which focus strongly on Chinese megatrends, especially the search for solutions to today’s environmental challenges. China now has some excellent universities which not only boast highly trained scientists and well-equipped laboratories, but also have access to generous financial resources. China has a vast number of university graduates, especially in the natural and engineering science so important to industry. A growing number of Chinese scientists have obtained experience abroad – having studied for degrees and post-graduate qualifications at foreign universities or having worked in other countries – and have a good knowledge of English or German. The thematic strengths of Chinese research lie in engineering and materials science, nanotechnology, ICT and chemistry.

### Weaknesses of the Chinese research and science system

China’s political governance assists structural establishment of the science system, but the restricted freedom of science and the dominance of state-owned enterprises in certain sectors hinder true innovation. Also, the number of policymakers and the range of policy interests are great and there are many overlaps between the responsibilities of the ministries and those of the various administrative levels (national, regional and local). China is (for now) strongly dependent on technology imports and technology transfer from industrialised nations. Cooperation in science and



industry is not well established. Distorting incentive schemes for scientists and the migration of highly qualified academics and scientists abroad weaken the country’s research power. In Chinese research, systematic approaches develop very slowly. This is a great disadvantage, especially in fields in which integrated solutions are needed (for example, in environmental technologies). In the education system, the promotion of creative thinking is not seen as a priority educational goal, so that generation of innovation is not incorporated into the training of young scientists. The social sciences and humanities are still rather poorly positioned. The research funding system mostly still does not function on the basis of independent, needs-oriented principles. Due to the greater focus on university education and the traditionally weak position of vocational education and training, the growing Chinese economy has to rely on a relatively small number of well-qualified workers with sufficient practical experience. Moreover, the university system mainly offers courses that are not focused on practical skills. The slow pace of development of a civil society makes stakeholder dialogue difficult (for example on environmental protection and social issues).



### Opportunities arising from cooperation with China

Despite the weaknesses mentioned, cooperation with China offers a wide range of opportunities. The country's size, vast population, growing middle class, continuing urbanisation and huge environmental problems create great demand for innovative products, technologies and services. Global challenges can also be jointly addressed. At the same time, research and technology made in Germany are greatly valued in China. Despite the associated negative impacts, the at times strict requirements and plans of the Chinese government give a certain amount of planning security for research cooperation. The often excellent infrastructure at Chinese higher education institutions and research institutes offer huge opportunities for German scientists. China's growing willingness to participate in the work of international standardisation committees makes it possible to develop joint standards. In addition, China can act as gateway to other Asian markets for German industry. With the government's current plans to reform the research (funding) system, opportunities arise for Germany to play an active role in the process and develop joint funding programmes with standardised implementation requirements (such as peer review). And due to the growing demand for well-trained workers (also by German companies operating in China), opportunities exist for German providers of initial and continuing education and training, and also of systematic vocational education and training advisory services. The wide-ranging affinity with Germany among many Chinese policy-makers and scientists provides a perfect basis for cooperation based on trust.

### Threats arising from cooperation with China

The greatest risk involved in cooperating with Chinese partners has long been the frequently unfavourable state-prescribed conditions that can foster undesired unilateral technology transfer and thus benefit potential Chinese competitors. This is especially critical in respect of key technologies and in research-intensive industry sectors. As obstacles that hinder cooperation, the German side sees unfair market conditions for German companies (for example, restrictions on technology exports from China), the forced joint ventures in some sectors (such as cars and trains) with the associated assignment of Chinese partners by the government, and the forced disclosure of technologies in return for investment approval. The frequent lack of transparency in policy decisions (concerning licenses and approvals, for example), difficulties in accessing information and data, poor preparation or lack of China expertise on the German side, and an unrealistic assessment of the potential opportunities and risks can also impede cooperation. Also, due to the dominance of the state in China, policies can change at any time and can thereby have a major impact on cooperation activities. In addition, intercultural differences can have a negative influence on research collaboration with China. This also applies to working on joint projects in higher education cooperation programmes. By way of contrast, mobility and exchange measures are not seen to involve great risks. However, it is important to ensure that both sides benefit equally from the exchange.

## 4.4 Points for consideration regarding future cooperation with China in research and education

Building on the aforementioned goals and guiding principles, and working with the SWOT analysis, the following points for consideration can be formulated regarding future cooperation between German stakeholders and Chinese partners in science, research and education.

### 4.4.1 Cooperation in research and innovation

- Research collaborations between German higher education institutions, research institutes and companies with Chinese partners make sense when German research and science is strengthened and/or innovation potential and new markets for German industry are opened up. Access to excellent research infrastructures and unique research locations are also good reasons to enter into cooperation activities.
- To ensure that cooperation activities with China are successful, a good knowledge is needed of the most important political and administrative conditions relevant for cooperation (applicable laws and regulations, such as those on IPR), the relevant research and science policy stipulations and the key stakeholders in China. Framework conditions which can be defined by the project partners themselves should ideally be clarified and agreed prior to commencing collaboration.
- Research collaborations are possible in fields ranging from joint basic research (e.g. in marine and polar research or geosciences) to application and industry-focused collaboration in the form of pilot plants and demonstration projects which have been adapted to meet Chinese needs (e.g. environmental technology and [waste] water treatment).
- It is expected that in the next ten to fifteen years, China will be among the world's leaders in many key technologies (and in some technologies it already is). It is thus important to closely monitor developments in these fields. Research collaborations serve this purpose well and should be conducted in areas where knowledge of the Chinese market can be acquired, German research and science can benefit from China's current expertise, capacities and infrastructures, and innovation potentials and markets can be opened up for German industry.
- Where technology and services are concerned, cooperation activities along the value chain make sense – for example, with Chinese users or final customers and in implementing projects at application level to find local solutions.



- In the case of cooperation in applied research, the aim should be to give German industry the greatest possible access to the Chinese market and, ideally, unrestricted use of German technology in China. Cooperation activities which require disclosure of critical knowledge of basic technologies or (forced) technology transfer should be approached with caution.
- When entering a cooperation partnership or collaborating in certain research areas, it makes sense to first engage in pre-competitive research collaboration as a means by which to build trust and establish cooperation mechanisms.
- One promising area of focus in German-Chinese cooperation involves joining forces to tackle China's megatrends and/or global challenges – such as environment, climate, urbanisation, energy, mobility, health, migration and demographic change. These are all issues which the Chinese government plans to address with long-term policies and measures. German research and industry are leading in many of these areas, meaning that promising opportunities for cooperation exist. China also serves as a testing ground for the development of experimental trials with new technologies, especially regarding the environment and urbanisation.
- Federal ministries and industry associations should closely coordinate their activities where industry-relevant and applications-related issues are involved. To ensure coordinated activity when approaching Chinese partners, existing and newly created national platforms could be used and, where appropriate, expanded to include a China component (for example, the National Platform for Electric Mobility and the National Platform for Industry 4.0). Coordination processes between German industry and Chinese institutions should be supported by policy measures where necessary.
- In the design and implementation of research cooperation activities, all relevant Chinese stakeholders (policymakers at national, regional and local level, research institutes and higher education institutions) should be involved to ensure successful and sustainable cooperation.
- Topics in which a greater influence can be achieved in a coordinated approach (in areas such as IT security, standardisation and certification, and IPR) should be addressed on a European and international level.

- The development and implementation of joint calls for proposals for research projects can help in achieving a better understanding of the Chinese research and research funding system. This includes jointly defined framework conditions, e.g. regarding the application process, evaluation and selection criteria and project administration.

#### **4.4.2 Cooperation in higher education and vocational education and training**

- Alongside scientific expertise, China expertise with regard to language and intercultural issues is an important factor for successful cooperation. Because China will play an ever-increasing role in research and industry, particular attention should be paid to fostering this expertise among German students, graduates and (young) scientists.
- Structural cooperation in which sustainable, institutionalised and non-personal structures of collaboration are established is a good way to increase the number of German students and scientists in China and thus foster China expertise. Cooperation in higher education should thus place greater focus on joint study programmes, dual degrees and PhD opportunities (including the recognition of qualifications and skills acquired at Chinese higher education institutions) and, where trust has already been built up in cooperation, on the establishment of joint institutes.
- When seeking cooperation partners, German higher education institutions should look to China's top institutions. In doing so, they should however consider the level of excellence in the respective discipline as many of China's 'second tier' higher education institutions demonstrate excellence in selected research fields.
- The German-Chinese cooperation in vocational education and training which has been established in recent years is aimed at fostering the training of skilled workers needed, for example, by German companies operating in China. Also, German expertise is to be used to create the structures needed to provide vocational education and training in a dual system and to develop and implement national standards for vocational education and training.



## 5. Activity areas and future cooperation measures

As part of the China Strategy, the following activity areas have been identified for future cooperation with China. Each area contains a brief overview of the current situation, the approaches to be taken and concrete measures for implementation. The aim is to establish a clear position of the BMBF regarding the desired content and framework conditions for German-Chinese cooperation.

### 5.1 Creating a better China expertise in Germany

Of fundamental importance to future German-Chinese cooperation in education, science, research and innovation is quantitative and qualitative expansion of Germany's China expertise. This involves:

- acquiring a general knowledge of China across all research topics and fields so this can be used in the work environment

- providing students, young scientists and experienced researchers with the opportunity to work and study in China or to implement joint studies and research projects with Chinese partners, thereby acquiring and/or expanding China expertise
- creating a well-founded, up-to-date knowledge base of the Chinese science, research and innovation landscape (e.g. stakeholders, existing cooperation activities, opportunities and risks involved in cooperation, and references to advisory services and other services available) and of developments regarding the general political and social situation in China

#### → Measure 1: Promoting innovative approaches for expanding China expertise at German higher education institutions

The BMBF will fund innovative concepts, ideas and measures aimed at supporting China expertise at German higher education institutions. The measure will focus on innovative concepts which pool China-related

activities of higher education institutions in an appropriate way and ensure their sustainable further development. The targeted promotion of China expertise is intended to benefit students and young researchers across all disciplines.

### → Measure 2: Promoting long-term study and research stays in China

To meet the growing demand in industry and research for graduates and scientists with China experience, more students and scientists should spend part of their academic training and research activities in China. German students who go to China often stay there for only a few months. This is too short a time in which to develop a deeper understanding of the Chinese research landscape and forge long-term contacts. It thus makes sense not only to increase the number of German students and scientists in China, but also to extend the length of their stay to more than the average six months. To achieve this, the BMBF sponsors structured exchange programmes between German and Chinese higher education institutions. Dialogue with Chinese partners on the award of grants to German students and scientists must also be intensified.

### → Measure 3: Establishing a China-focused monitoring system tailored to the needs of stakeholders in science and research

The aim is to set up a regular, evidence-based and target group-oriented monitoring of current developments and trends in Chinese research policy (for example, analysis of Chinese strategy documents related to research and education, indicator setting, creation of research landscape maps and stakeholder maps).<sup>20</sup> The data and statistics collected will be regularly updated and made available to the respective stakeholders.

Information supplied by the BMBF (such as via the 'Kooperation International' web portal) and via third-party information services (other ministries, the EU, the OECD, UNESCO, German and Chinese science organisations) and Chinese strategy documents of

relevance to cooperation with China should be screened and analysed with a view to the needs of German stakeholders from science and research. Particular attention should be paid to information about the Chinese higher education, science and research system (e.g. university rankings, information on science parks, research landscape maps) and improved use of existing advisory services (e.g. from the German Chamber of Commerce [AHK]) concerning technology-based cooperation (known as technology scouting).

Targeted information gathering is an integral component of monitoring activity. The BMBF will thus conduct dedicated events, also with Chinese partners. In addition to collecting and processing information and data, scientific studies will be commissioned as needed and conducted by external experts and research institutes. Depending on respective needs, studies can be conducted on the cooperation potential of selected Chinese regions and stakeholder maps can be developed. In this regard, specialist workshops and fact-finding missions should be organised to utilise expert knowledge and better assess China's research landscape and capacities in certain research areas.

## 5.2 Building sustainable cooperation structures and researcher networks

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The funding of structurally strategic cooperation between German and Chinese higher education institutions has intensified significantly in recent years. Given the still huge developmental potential, the BMBF intends to:

- significantly strengthen the institutional level by expanding strategic partnerships between German and Chinese higher education institutions, offering dual degree and PhD programmes, and establishing joint institutes, laboratories and research structures
- use the above activities to foster networking between German and Chinese scientists
- secure the sustainability of networks through targeted alumni work

<sup>20</sup> EFI report 2012 recommendation: 'The further development of China's innovation system should be monitored with great attention and should continuously be analysed for opportunities and threats.'



Various forms of promoting higher education cooperation with China are already well established (such as international study and training partnerships, dual degree programmes, courses and study programmes of German higher education institutions abroad). Although both Chinese and German stakeholders benefit from these programmes, to date they have often been financed solely by the BMBF. New types of cooperation are thus desired which link education and research more closely, effect structural improvements or create new structures on both sides, and involve young German scientists (Masters, PhD and post-doctoral students) more than before in China's dynamic development processes. Innovative projects are needed which provide great visibility in China and Germany, to ensure that they can serve as a model for higher education partnerships.

In all of this, German higher education institutions must exploit the opportunities offered by China's internationalisation efforts. Internationalisation is playing an ever increasing role in Chinese universities and thus a greater commitment on the Chinese side can be expected. German higher education institutions can benefit from this in many ways (such as in the recruitment of doctoral students, structured exchange programmes with significantly better study conditions for Germans in China, and in the long run intensified research cooperation).

In the international race for the Chinese education market, German higher education institutions have a real chance of paving the way towards more intensive strategic partnerships and with them a better position in the Chinese education market. These interests are equally shared by Germany and China, and China is now willing to introduce the necessary funding measures. Attention must be given to ensuring parity in funding, transparency and quality control.

#### → Measure 4: Promoting structural strategic cooperation activities in higher education

The jointly financed 'German-Chinese model partnerships in higher education' will be implemented as part of the DAAD's 'Strategic partnerships and thematic networks' programme. The idea is to promote cooperation projects which can serve as models for future cooperation in higher education, develop a visible profile and address the focal areas in German and Chinese education and science policy.

Expansion of joint dual degree and doctoral programmes is to be further pursued. Courses of study which include a year in China, combined courses (China or Asian studies plus one or more disciplines such as economics, law and politics) and courses for Chinese-German interpreters/translators are also to be considered.

### → **Measure 5: Intensifying activities of the Sino-German College for Applied Sciences**

The funding of joint higher education institutes such as the Sino-German College for Applied Sciences (CDHAW) established at Tongji University in Shanghai in 2004 is one particular example of structural support and a success story in BMBF-funded German-Chinese higher education cooperation. Collaboration with partner institutes under the umbrella of the Sino-German University (CDH) will be enhanced. In addition, the number of German students who spend a year of study at the CDHAW and acquire a dual degree is to be steadily increased.

### → **Measure 6: Promoting sustainable research cooperation between German and Chinese higher education institutions and research institutes**

At the 3rd intergovernmental consultations in October 2014, the BMBF and the MoE decided to establish research laboratories and other types of research infrastructure at excellent Chinese higher education institutions to be used for bilateral research activities. The aim is to obtain important research results by means of close cooperation and to train top-class research staff on both sides. German research institutes are also to be involved.

### → **Measure 7: Establishing an alumni network**

To ensure sustainability of the experience and contacts made during studies and research activities in the respective countries, targeted alumni work is needed. This will be based on the experience and knowledge of German students and scientists who have lived in China and have established long-standing contacts with Chinese partners. At the same time, German science is to receive greater access to Chinese alumni who have spent some time in Germany. Also, networking between the two sides will be fostered. Cooperation with Chinese industry associations based in Germany will also be intensified.

## 5.3 Networking German stakeholders and designing policy dialogues

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A basic prerequisite for successful cooperation with China is a close network of German stakeholders and ongoing exchange of information on the activities they conduct with their Chinese partners. The results of this coordination process at national level can then be used in a subsequent step at international level.

### → **Measure 8: Intensifying exchange with German research, funding and intermediary institutions, higher education institutions and other ministries**

To ensure the exchange of information and the coordination of activities with German research, funding and intermediary institutions, higher education institutions and other education and research organisations, the BMBF will issue invitations to regular meetings of the ‘China round table’.<sup>21</sup> Special attention will be paid to the strategic dimension of cooperation activities conducted by these organisations. The meetings will focus on current trends in Chinese research and education policy, experience gained during collaboration and success stories and problems arising from cooperation activities. At the same time, the BMBF will also make a pro-active contribution to relevant meetings called by the German Federal Foreign Office and other ministries. As in the past, the science counsellors at the German diplomatic missions in China will be involved in all information exchange.

### → **Measure 9: Designing the bilateral policy dialogue mechanisms in education, science, research and innovation**

To intensify cooperation and reflect on its development, the BMBF will use the bilateral dialogue mechanisms established between the BMBF and the Chinese

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21 EFI report 2012 recommendation: ‘Several major scientific organisations have each developed their own China strategy and established subsidiaries and research institutes in China. The large number of initiatives suggests that maybe too much of a good thing has been done. In the future, these diverse activities of scientific organisations abroad (the DFG, the FhG, the HGF, the MPG and others) should be consolidated even further, with the aim of strengthening the larger German scientific community in China.’

partner ministries MoST and MoE (namely the Joint S&T Commission, thematic Steering Committees, the Strategy Dialogue on Education Policy and the German-Chinese Alliance for Vocational Education and Training) along with the German-Chinese intergovernmental consultations which are held every two years. This will be done in close cooperation with the relevant German stakeholders. It is also hoped to include further relevant partners on the Chinese side, amongst others those at regional level.

→ **Measure 10: Participating in European and international bodies and initiatives relating to education and research cooperation with China**

As a member of numerous EU bodies and committees, the BMBF already plays an active role in shaping the European Research Area. Of particular relevance is the close cooperation with the Directorate-General for Research and Innovation and the Directorate-General for Education and Culture. The BMBF will also participate intensively in EU-level dialogues and processes relating to cooperation with China. This includes work on the China initiative of the Strategic Forum for International Science and Technology Cooperation (SFIC)

and participation in research cooperation projects with China conducted under Horizon 2020. The BMBF will also call for representatives of the EU Member States to be allowed to attend meetings of the Joint Steering Committee on Science and Technology hosted by the EU Commission and the MoST and will position itself in EU programme committees on cooperation with China. In addition, after assessing their relevance in terms of German-Chinese cooperation, the BMBF will also participate in China activities conducted by international organisations such as the OECD and UNESCO. It will also support greater coordination between the science counsellors at the various EU Member State embassies in Beijing.

## 5.4 Optimising conditions for German science and research engagement in China

Prevailing political, economic, legal and institutional conditions and their implementation have greatly influenced the outcomes of cooperation in research and innovation. Those framework conditions must be



designed in a way to ensure that German interests are safeguarded and international regulations and agreements adhered to. At the same time, Germany must represent its interests and play a pioneering role in international bodies and dialogue processes (for example, in the International Organization for Standardization, ISO) which focus on framework conditions for cooperation with China.

→ **Measure 11: Intensifying the dialogue with China on framework conditions for research and education cooperation**

The conditions enabling German-Chinese cooperation should guarantee fair competition, fair market conditions for foreign companies and the protection of intellectual property.<sup>22</sup> This applies both to their design in the form of legislation and requirements, and to their practical implementation by official bodies and offices. Involuntary technology transfer and forced disclosure of knowledge (for example in the form of prescribed joint ventures with Chinese partners and in the context of investment approvals and issuance of certification/licenses) should also be addressed in relation to research cooperation with China. German companies operating in China should also be free to choose the country in which they register their innovations as patents. Better regulations to avoid junk patents and junk trademarks and the coexistence of confusingly similar brands are also needed.

Other issues which could also influence cooperation, such as customs regulations on the import of R&D equipment and ensuring equal access to laboratories, large-scale facilities and public research promotion announcements, should continue to be discussed with the Chinese side. To examine the framework conditions, ongoing dialogue with the relevant Chinese stakeholders is proposed. This could, for example, take place in the context of the Sino-German Innovation Platform that was established at the 1st intergovernmental consultations in 2011 or via existing national platforms like the National Platform for Electric Mobility and the National Platform for Industry 4.0.

In working with its Chinese partners, the BMBF will also strive to improve conditions in China to achieve an increase in numbers and lengths of stay for German students and scientists. This will involve expanding English-language study programmes (courses, modules) on the Chinese side and the award of more scholarships to German students (e.g. by the China Scholarship Council). And in dialogue with the MoE and Chinese higher education institutions, the BMBF will work towards an improved welcoming culture for German students (e.g. support in the allocation of lodgings and on administrative issues, the sufficient provision of Chinese language courses and discipline-related courses in English, and well-equipped libraries for coursework).

→ **Measure 12: Intensifying exchange regarding standards and certification with responsible German ministries and bodies**

Internationally applicable norms and standards must be introduced in China without delay. This is an area in which the German-Chinese Standards Commission established by the German Federal Ministry for Economic Affairs and Energy (BMWi) and the Standardization Administration of China is active. In addition, an online German-Chinese Standards Information Portal is managed by the German Institute for Standardization (DIN) and the Standardization Administration of China. The BMBF aims to intensify exchange with relevant ministries and bodies to ensure that the interests of science organisations are also represented.

## 5.5 Promoting key technologies

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### 5.5.1 Electric mobility

To intensify German-Chinese cooperation in electric mobility, the Sino-German Strategic Platform for Electric Mobility was launched following the 1st German-Chinese intergovernmental consultations in 2011. The aim of the platform is to ensure successful, sustainable development of and market entry for electric mobility by means of policy cooperation to create the necessary substantive and strategic frameworks. Exchange between the two countries on the issue of

<sup>22</sup> EFI report 2012 recommendation: 'The Federal Government should monitor China's progress in the field of intellectual property and report on their findings on a regular basis.'



electric mobility is to be intensified and joint strategies are to be developed on all related aspects and areas of application. Ministries from both sides are involved in the process. In Germany, these comprise the BMWi, the Federal Ministry of Transport and Digital Infrastructure (BMVI), the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the BMBF.

→ **Measure 13: Further developing the Sino-German Strategic Platform for Electric Mobility**

Interministerial coordination at working level has proven successful. Germany must continue to consolidate its interests. This is the only way for cooperation activities to be conducted to the mutual benefit of both sides. R&D cooperation and the enabling conditions for its implementation are addressed in a logical and consistent manner. Annual meetings are used to develop a cross-departmental strategic approach to German-Chinese cooperation on electric mobility. The results of the German-Chinese projects promoted under the TU9

Sino-German electric mobility initiative will be taken into account.

**5.5.2 Photonics, optical technologies**

The main focus of German-Chinese cooperation in photonics and optical technologies lies in LED lighting (solid-state lighting, SSL). Both countries are interested in the industrial development of these technologies because they represent a global market and LED lighting is also a key technology in both governments' energy efficiency policies. German industry sees excellent opportunities for cooperation with mutual benefit, both through further development of the Asian markets and through collaboration along the value creation chain.

→ **Measure 14: Implementing R&D projects for LED technology use**

The BMBF continues to support cooperation in research fields of relevance in the development of standards (optical metrology, testing and certification processes, the investigation of the biological, medical

and social effects of light, and the classification and definition of market segments). The BMBF is currently looking at the possibility of conducting further joint R&D projects on the use of LED technology (in agriculture, schools and municipalities). Here, it is necessary that both sides involve the ministries and authorities responsible for the various applications at national, regional and local level.

### 5.5.3 Digital industry

China and Germany are technologically strong, export-oriented industrialised nations. Economic and technological links between the two countries are growing. In particular, the rapid digitalisation of industrial processes sees both China and Germany in transition. Both nations want to exploit the opportunities this trend brings.

In light of the existing cooperation activities and economic links, it is in Germany's interest to build a (new) innovation partnership with China in the field of digital industry. To ensure this, Germany's cross-cutting policy approach should be a fundamental component of such cooperation in a similar way to that already achieved in electric mobility activities.

The core elements of the new High-Tech Strategy should be included in bilateral cooperation agreements. In its research and innovation strategy and in its associated measures (such as in Industry 4.0), the BMBF mainly relies on SMEs. The SME sector especially, and the German supply industry in particular, currently play a key role in China's industrialisation. A focus on SMEs should thus be an integral part of German-Chinese cooperation.

Apart from the cross-sectoral approach, the instruments to be used are also a deciding factor. To achieve the goal of entering into an innovation partnership in digital industry with China, cooperation potential must be developed and suitable cooperation models designed. Joint projects between German SMEs and industry partners in China could, for example, be established via existing industry networks.

This calls for:

1. A dialogue process between Chinese and German industry which includes their research partners and uses structures that already exist on both sides (e.g. the National Platform for Industry 4.0 on the Ger-



man side). A fact-finding mission organised by the BMBF, perhaps in cooperation with the BMWi, and involving companies could serve as a first step.

2. The identification of critical obstacles to cooperation and the development of proposed solutions: for example, the exchange of sensitive, competition-relevant data is central to cooperation on digital industry. A first step would be to establish secure communication and the encryption of company intranets. Secure data environments are vital especially for the strong German SME sector, something that is difficult to find both locally and globally. A secure data environment is the basis on which to build new industry partnerships, for example in automation and logistics, and in the growing trade of goods between the two countries. It will become more important to be able to identify goods being shipped in cross-border trade. Germany and China could set an example by showing how this can be done.
3. The areas of cooperation to be defined: the topic 'Smart Services for Smart Cities' is an ideal choice for kicking off such cooperation activities. In the future, joint activities should address social challenges. It is important to ensure that, as with the new High-Tech Strategy, technological and social innovations are developed jointly.
4. Definition of the type of cooperation involved: Collaborative projects are still the instrument of choice in such activity. These should in the future cover not just technology, but also business models and process innovations.

Implementation partnerships of this kind at industry level can secure the success of an innovation partnership in digital industry between China and Germany.

→ **Measure 15: Exploring opportunities for an innovation partnership between China's and Germany's digital industries**

As part of a delegation trip planned for autumn 2015, the BMBF will explore opportunities for an innovation partnership in digital industry between China and Germany.

## 5.6 Promoting the life sciences

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In China's research and innovation landscape, the life sciences are less of a priority than technology-focused disciplines such as ICT and mechanical and systems engineering. Nonetheless, China strives to attain international standing in this research field. This goal is incorporated in all of its key policy programmes, such as the 12th Five-Year Plan.

An agreement was signed on the establishment of the Sino-German Life Science Platform during the 1st German-Chinese intergovernmental consultations in Berlin in June 2011. The platform will be used to consolidate and further develop German-Chinese cooperation activities in the life sciences.

### 5.6.1 Health care industry

For the health care industry, it was agreed as part of a prioritisation process that the Sino-German Life Science Platform will be used to focus activities on biomaterials. In medicine, biomaterials are used for therapeutic purposes and diagnostics.

→ **Measure 16: Implementing a pilot project to promote industry-led collaboration projects on biomaterials using the '2+2 model'**

The MoST, the China National Center for Biotechnological Development and the BMBF are currently developing and coordinating a model for bilateral funding activities in the form of a pilot project. The aim is to promote industry-led collaboration projects in the biomaterials sector using the 2+2 model (approximately five projects with a total volume of EUR 5 million each on either side). In addition, a joint database is planned to list and promote life sciences institutions and stakeholders from German and Chinese industry and research.

### 5.6.2 Bioeconomy

Chinese priorities in bioeconomy arise from the need to ensure food security and overcome the scarcity of natural resources (especially cropland, water and fossil fuels). Opportunities and the need for cooperation with China are thus topic-related and varied:

- In industrial biotechnology, fermentation plants will be built in China to generate bulk products for use in the animal feed and food industries.
- China aims to become a leader in the development of modern biotechnological processes.
- China already plays a role in bio-based chemistry, especially in the production of Vitamin C, penicillin, citric acid and glutamine.
- In the coming years, China will expand its capacities in enzyme production towards biorefinery development with the help of foreign cooperation.

A fact-finding mission conducted in spring 2015 confirmed that China is five to ten years behind Europe in bioeconomy, but is catching up. Industry already sees opportunities for cooperation.

#### → Measure 17: Continuing the funding programme 'Bioeconomy International'

The 'Bioeconomy International' initiative launched under the 'National Research Strategy Bioeconomy 2030' is designed to promote international research cooperation in bioeconomy. To take account of the very different thematic and discipline-related needs in effective support of the bioeconomy in cooperation with China, China was named for the first time as a preferred cooperation partner for the initiative in 2015. The collaborative projects will make an important contribution to the following areas of activity: securing global nutrition, managing agricultural production sustainably, producing safe and healthy food products, using renewable resources on an industrial scale and developing energy sources based on biomass. Apart from the technological issues and development goals, socio-economic aspects and system approaches are also of importance. The response to the initiative will be used as a gauge for the potential of subsequent 2+2 cooperation activities (projects involving industry and research partners on both sides).

## 5.7 Mastering global environmental challenges

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China has a range of globally-relevant environmental challenges to overcome. Its strong economic growth brings many developments which impact the environment, in some case seriously. The dramatic rise in industrial production and growing urbanisation are causing increased air and water pollution. More than 90 percent of the 190 cities in China that monitor and report their air status exceed the national thresholds for average annual air pollution from fine particles. In 2014, the Fine Particles Index showed more than 200 micrograms per cubic metre of air – almost ten times the threshold issued by the World Health Organization (WHO). Energy consumption is also on the rise. At 9.8 million tonnes and a share of 27 percent (2012) (and rising), China is the world's biggest emitter of carbon dioxide (CO<sub>2</sub>) and accounts for some 70 percent of the global increase in carbon emissions.



The overall situation makes China a key cooperation partner for BMBF in terms of sustainable development. The environmental situation in China has far-reaching global consequences. Germany, as a leading research and technology nation, can and must contribute to overcoming global environmental challenges. Also, China serves as an attractive market for German sustainability researchers and companies, and the opportunities this brings should be strategically exploited. The BMBF is thus working to create the right framework conditions for German partners to enter into cooperation agreements with China.

On-site demonstration plants are an example of a strategic tool for use in paving the way for German-made sustainability innovation in China. Innovation centres that offer such pilot projects and demonstration plants in China can open the door for German technology providers (see also the section on cooperation in sustainable water management below). To ensure that German companies can join forces with Chinese partners, innovation financing is needed. Research cooperation should thus (where necessary) be accompanied by funding mechanisms offered by institutions such as the KfW Development Bank.

On the thematic side, the BMBF has prioritised sustainable water management, sustainable urban development, marine and polar research and geosciences. Cooperation potential is also seen in certain areas of the renewable energies sector and climate research. Regarding the modernisation of coal-fired power plants, activities focus on their adaptation to enable use of available technologies.

The following instruments and measures designed to master global environmental challenges outline the priorities to be pursued while building on former or current cooperation activities.

### 5.7.1 Sustainable water management

China is the world's biggest consumer of water. Given the region's extreme regional water shortages and water pollution in industrialised areas, there is a great need for innovative water technology. Under the 12th Five-Year Plan, some EUR 50 billion should be invested in the water sector by 2015, mostly in facility construc-

tion. Large amounts of funds have also been allocated to modernising and expanding the wastewater system and to improving and constructing wastewater treatment plants. Major investment is also planned in innovative sewage sludge treatment plants and water recycling plants, as well as in the introduction and installation of monitoring and control systems in the water sector.

China's vast investment in research and development, infrastructure expansion and international cooperation provide an opportunity to put German water technology to use in the specific conditions prevailing in China. With the implementation of the Chinese Mega Water Program for the period up to 2020, there is considerable need for German environmental and water technologies and for support from German researchers.

Responsibility for water resources in China is spread across 14 state-run institutions – a situation which has presented numerous obstacles in terms of coordinated implementation of water management goals and measures. The MoST, the Ministry of Housing and Urban-Rural Development and the Ministry of Environmental Protection are the BMBF's major partners in implementing the German-Chinese Research and Innovation Programme 'Clean Water' and the Chinese Mega Water Program.

With the aim of developing long-term, in-depth cooperation on sustainable water management, the MoST and the BMBF launched the joint Research and Innovation Programme 'Clean Water' in 2011. The outcomes from this programme will be used in the planning of sustainable water supply and wastewater management in megacities and their catchment areas (e.g. Lake Tai, Lake Dian and Lake Chao, and the Liao river). These activities will involve the 'Clean Water' Innovation Centre opened in Zhangjiang Hi-Tech Park in Shanghai in 2014, which is operated by German companies (partially organised under the German Water Partnership) and Chinese companies, and the newly-founded Cooperation Centre for Environmental Professions in Qingdao. Future German-Chinese consultations must thus address the need for innovative, highly-automated, semi-centralised and decentralised solutions for cities as a future R&D topic.



In water management cooperation, collaboration between some 15 German and Chinese partners from science and industry in the SEMIZENTRAL consortium project also plays a key role. The project focuses on establishing a semi-centralised water supply and wastewater treatment centre for sustainable housing development in rapidly growing urban areas, and especially in water-poor regions worldwide. Serving approximately 12,000 inhabitants, the plant opened in Qingdao in April 2014 is the first of its kind in the world. The installed technology makes for drinking-water savings of between 30 and 40 percent, energy-independent operation and the extraction of phosphorus and other valuable resources.

Distribution of innovative, sustainable water and wastewater technologies that have been adapted to Chinese needs is to be further intensified in the future. The BMBF will promote suitable measures in cooperation with the finance sector.

#### → Measure 18: Supporting German industry in distributing innovative environmental/water technologies adapted to Chinese needs

German industry must be supported in distributing innovative environmental technologies which have been adapted to Chinese needs. This occurs via a wealth of cooperation initiatives which have been launched in recent years and which must be strategically enhanced and aligned as needed. In the water and wastewater sector, for example in activities conducted at the 'Clean Water' Innovation Centre in Shanghai, better conditions for German partners in China are to be created by offering VET in relevant occupations, adapting standards and regulations, and providing policy support in the award of KfW loans.

→ **Measure 19: Continuing the bilateral Research and Innovation Programme ‘Clean Water’ (CLIENT/FONA3 Framework Programme) in cooperation with MoST**

International partnerships on sustainable environment and climate protection technologies help to develop innovation potential and open markets for German companies, higher education institutions and research institutes. The highly successful BMBF CLIENT Programme (2010–2017) comprising a range of consortia projects involving water and wastewater is to be continued and enhanced with the announcement of a new call for proposals (planned for 2015). In this way, existing measures can be improved and – where appropriate – water management cooperation intensified and secured.

### 5.7.2 Urbanisation

The trend towards rapid growth of China’s cities is expected to continue in the coming years. Cooperation with China in urbanisation research is of interest to German researchers and companies. The increasingly high standard of Chinese research enables cooperation on an equal footing, though this mainly relates to the technical aspects of urbanisation. In recent years, a huge market has opened up in China for technologies designed to assist and foster sustainable urban planning. There is considerable catching up to do in transdisciplinary research that takes in all the relevant interest groups and social science issues needed to develop holistic models for sustainable urbanisation. German researchers are thus highly sought-after as cooperation partners and the BMBF wants to develop targeted measures to provide adequate framework conditions.

→ **Measure 20: Supporting Chinese participation in the BMBF Science Year ‘City of the Future’**

In order to be involved in intensive discussion of models for sustainable urbanisation, identifying solutions to the problems of growing megacities and to extend networks between German and Chinese researchers, China – as the first foreign partner country – will participate in selected events held under the auspices of the BMBF Science Year 2015 ‘City of the Future’. A joint

conference was held in China on the topic of ‘Sustainable Urbanisation’ in May 2015. Further measures will link to the Science Year and support medium-term cooperation on urbanisation.

→ **Measure 21: Setting-up a call for proposals on ‘Sustainable Urban Regions’ which is also open to Chinese-German consortia**

Building on the extremely successful funding programme ‘Research for the Sustainable Development of Megacities of Tomorrow’, a new call for proposals on ‘Sustainable Urban Regions’ will be developed to which Chinese-German consortia may apply. Concrete design of the future BMBF programme on sustainable urban regions will be developed in an international agenda process under the Science Year 2015 ‘City of the Future’.

Because a large share of greenhouse gas emissions are generated in urban areas and because cities are the hardest hit by the negative impacts of climate change (such as extreme weather events), climate-related adaptation measures and strategies to avoid greenhouse gas emissions should be considered in the complex field of sustainable urban planning.

### 5.7.3 Renewable energies

China is breaking global records in the expansion of its renewable energies activities. It already ranks among the world leaders in applied renewables research and aims to lead the world in renewables technology in the next 15 to 20 years. The Chinese government oversees and organises energy research in a top-down approach. Only in cases where knowledge transfer can be expected are technology imports and transfer and demonstration projects with German partners permitted. Cooperation in photovoltaics, wind energy, bioenergy and hydropower involving one-way transfer of technology should thus be avoided. According to German industry, German energy technology companies are being kept out of the Chinese market. They are seen as competitors in the fight for the global market. According to German technology developers, China follows a strategy that does not allow for joint pilot projects or technology-based joint ventures with German companies from the energy sector. Framework conditions

in China change at a rapid pace, making it difficult to enter into long-term bilateral research cooperation on energy.

Germany currently places importance on energy-based science and research cooperation as follows:

→ **Measure 22: Promoting exchange of young German and Chinese researchers and students in the field of renewable energies**

In order to promote the exchange of young German and Chinese scientists and students in the field of renewable energies, joint workshops should be held with representatives from German and Chinese policymaking, industry and science to explore potential areas of cooperation and associated measures. Germany gives priority to interdisciplinary and systemic approaches.

→ **Measure 23: Implementing scientific accompanying research on the impacts of large-scale energy infrastructure projects on environment and nature**

Joint German-Chinese accompanying research projects are needed on the environmental impacts of large-scale energy infrastructure projects (grid expansion, pump-water storage, hydropower). Both countries can benefit from this type of cooperation activity.

→ **Measure 24: Acquiring more knowledge on the status of renewable energy research in China**

A map of excellence in energy research in China should be developed in cooperation with the Chinese partners. The aim must be to illustrate the dynamism of the Chinese research landscape and its areas of excellence. China largely remains uncharted territory for German



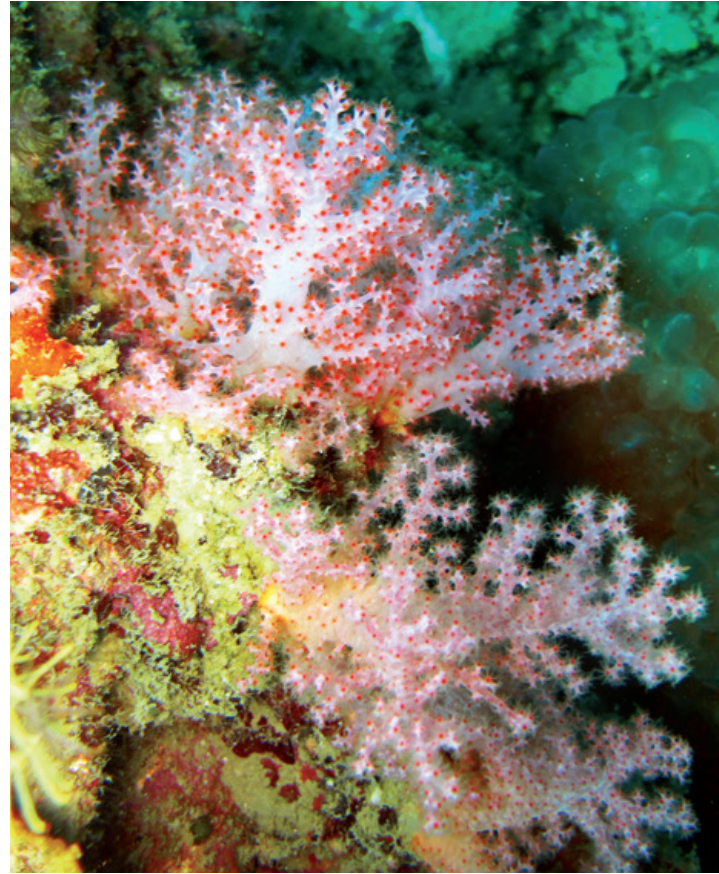
energy research. Efforts should also focus on identifying and evaluating existing German-Chinese technology cooperation as well as renewables-based collaboration between the EU Member States and China (including regular monitoring).

#### 5.7.4 Climate

Given the complexities of the climate research landscape (climate system research, impact research, research on emissions reduction/mitigation and alignment/adaptation, economic and social science research on perception and regulation of various climate-related policy areas), it makes sense at this stage to follow a bottom-up, decentralised, science-driven monitoring and cooperation strategy with China. Several German research institutes are currently engaged in direct exchange with Chinese research institutes. For example, Helmholtz centres and higher education institutions maintain extremely close, long-standing cooperation relationships with a large number of Chinese research institutes and meteorological services.

#### → Measure 25: Preparing a status report on the strengths and weaknesses of Chinese climate research to identify potential areas for future cooperation

China's central government aims to catch up quickly in climate research and it makes sense to monitor and analyse this process. As a first step, a structured, systematic overview of the current status of and the expected developments in climate research in China is needed to ensure that Germany does not miss out on important research trends that are highly dynamic in China. At the same time, analytic monitoring (policy and scientific exchange, etc.) of developments in China is also needed to identify potential areas for future cooperation. In addition, it must be determined whether and to what extent other nations are cooperating with China in this research area so as to identify any added value to be gained in a European context.



#### 5.7.5 Marine and polar research

China participates in all international research programmes concerning marine science and its publications in this field have attracted worldwide attention. Particularly worthy of note in this regard are the fields of marginal sea and coastal research, as well as marine resources. Opportunities for cooperation arise out of the possibility to conduct research at unique research locations. For Germany, which borders the North and Baltic seas, investigating China's marginal seas is of interest in conducting comparative studies on oceanographic and geochemical processes. Coastal research in China opens up new research fields for German research institutes and higher education institutions. With China's increasing interest in all aspects of marine resources, it is expected that significant effort will be put into developing direct and indirect measurement techniques for shelf regions and deep sea areas.

→ **Measure 26: Continuing the long-standing, intensive marine and polar research cooperation with the State Oceanic Administration**

The framework for structuring the proposed measures is provided by the Joint Declaration on German-Chinese Research Activities in Marine Research (2013–2020) signed between the BMBF and the State Oceanic Administration in August 2012. In 2013/2014, a first bilateral call for proposals was published concerning deep-sea research and changes in the marine environment and polar research, and suitable projects were selected for funding.

Despite these initial activities, no concrete German-Chinese cooperation activities have taken place in marine raw materials research so far. Therefore the next step is to hold bilateral workshops in order to assess the need for such research and to publish further calls for proposals as appropriate.

### 5.7.6 Geosciences

Earth system research plays an ever-greater role in China. This primarily involves environmental and georisks, particularly the development of regional response strategies to climate change and assessing the risks from natural perils. Due to its geological conditions, China frequently suffers serious earthquakes and there has also been an increase in large-scale flooding and landslides along its major rivers.

The Chinese side shows great interest in cooperation in the fields of risk assessment and early warning. One general weakness in China's current science and research system is the inconsistent systemic focus which can result in error-laden approaches – especially in illustrating complex geoproceses.

→ **Measure 27: Intensifying cooperation in natural disaster and georisk research, and the development of monitoring and early-warning systems**

Cooperation in research on natural disasters/georisks and the development of early warning systems for damage limitation offer considerable research poten-

tial for Germany. In the case of georisks, this includes multi-risk analyses which take into account the cascade effect in natural and anthropogenic systems and future risk assessment in relation to urbanisation processes. Other important research fields include the development of monitoring and early warning systems, especially concerning georisks, and the integration of remote sensing and geological engineering expertise.

## 5.8 Promoting the humanities and social sciences

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In social sciences, and to an extent in the humanities, Chinese research has improved its international ranking in recent years. However, cooperation in the humanities and social sciences is made difficult due to diverging paths of discourse and the fact that theoretical contributions from Chinese scientists are, even today, strongly ideology based. Another problem is that free access to social science-relevant data is not always given and the data that is available is not always reliable. Added to this come research topics which are still at risk of being subject to government controls and censoring.

Nonetheless, cooperation with China in the humanities and social sciences brings great opportunity. Due to globalisation processes and migration, knowledge of local and regional, transnational and transcultural conditions and relations plays an ever greater role. The humanities and social sciences can supply a wealth of knowledge on cultural and social structures and processes.

→ **Measure 28: Promoting social science cooperation with China in broader-based project funding lines**

The BMBF promotes social science cooperation with China in broader-based project funding lines which are linked to cooperation with other disciplines and intra- and inter-university networking. This is the funding approach used, for example, for the Käte Hamburger International Centres in the Humanities, for research into cultural heritage and for area studies. Funding of cooperation with China will also be possible along a



new project funding line for cultural heritage planned as part of the current framework programme ‘Humanities, Cultural and Social Sciences’.

→ **Measure 29: Establishing an International Centre for Advanced Studies in the Humanities and Social Sciences in China**

German-Chinese cooperation in the humanities and social sciences must be strengthened in structural terms. It is thus planned to establish an International Centre for the Humanities and Social Sciences in China, where German and Chinese researchers will work together in an interdisciplinary approach on jointly selected key research topics. The Centre should serve as a visible hub for German-Chinese exchange on these topics.

## 5.9 Intensifying cooperation in vocational education and training

Cooperation in VET has steadily intensified since the establishment of the German-Chinese Alliance for Vocational Education and Training in 2011. For reasons of mutual interest, the BMBF and the MoE support cooperation between industry and education institutions to promote a high-quality, German model of VET in China. One of the major aims of the Alliance is to foster China’s VET reform efforts, especially as regards integrating elements of the dual system, the development of VET standards and recognition of VET qualifications.

The BMBF guidelines for VET cooperation comprise the five core principles of the German VET system as set out in the German government’s Strategy for One-Stop International Cooperation in Vocational



Education and Training: 1. Cooperation between ‘social partners’ (management and labour organisations), industry organisations and the state; 2. Learning within the work process; 3. Acceptance of national standards; 4. Qualified VET personnel; 5. Institutionalised VET research and advice.

→ **Measure 30: Intensifying cooperation in quality assurance**

Against the backdrop of the Chinese government’s reform plans for a practice and labour market-oriented VET system (see in particular the MoE strategy paper from June 2014 on establishing a modern VET system), a range of approaches and models are currently being tested in China. A national strategic approach is still in development. The BMBF wants to support the MoE in defining evaluation criteria for best-practice pilot projects in accordance with the five core principles mentioned above. In coordinating these efforts with its Chinese partners, the BMBF will emphasise the need for standards. This will take place both in the interests of quality assurance and to boost the image of German VET in China.

→ **Measure 31: Developing regional partnerships in cooperation on vocational education and training**

As the Chinese government named the provinces as incubators of new practice-oriented VET models in its strategy paper from 2014, the BMBF will take a demand-focused approach to boosting cooperation with specific regions. Lighthouse projects for company-oriented VET approaches will be conducted with German assistance in provinces that can serve as role models. Targeted fact-finding measures by the German Chamber of Commerce (AHK) and the German Office for International Cooperation in Vocational Education and Training (GOVET) will be used to identify potential projects and secure the involvement of German companies in developing them.

→ **Measure 32: Providing assistance in the implementation of dual structures via the VETnet project**

In China, the BMBF-funded VETnet project (German chambers worldwide network for cooperative, work-based vocational education and training) will serve as

a broker for German dual approaches in cooperation with Chinese partners and local industry. VETnet is designed to establish dual components in the VET systems in selected countries. Apart from the school-based education component, structures for vocational education and training using the dual model comprise the work-based component and the involvement of the relevant trade chambers. The establishment of similar structures, which do not yet exist in China, has been promoted in recent years through the advisory services of the AHK in Shanghai to ensure high-quality VET – especially for German companies in China. The AHK has become a focal point of contact for the BMBF in China and also for Chinese partners, particularly at regional level. Many regional governments are currently turning to the AHK Shanghai to have their pilot projects certified as being in line with the dual principles. The VETnet project thus puts the AHK in a position to help embed the dual principles at regional level.

→ **Measure 33: Networking German stakeholders via an integrated project and alumni database**

A wide range of cooperation activities between higher education institutions, vocational colleges and companies are currently emerging at regional level in China. People with personal experience of Germany's dual system play an important role in ensuring the quality of the pilot projects being conducted. By linking the databases operated by GOVET (project database), iMOVE (database for VET providers) and the GIZ (VET measures, including the alumni portal) it should be possible to improve networking between individual stakeholders in order to launch new initiatives.

→ **Measure 34: Establishing sustainable cooperation between the Federal Institute for Vocational Education and Training and Chinese partners**

Research on vocational education and training provides the basis for new policy approaches in VET. When addressing problems in VET quality assurance, China tends to look at the purely academic side. It is thus essential to foster dialogue with the relevant Chinese research establishments to (further) develop and evaluate potential methods to allow the transfer of VET to China. The aim is to obtain joint research results and

secure mutual exchange of information. In developing a new approach to cooperation between the Federal Institute for Vocational Education and Training (BIBB) and China, Chinese researchers will be offered research stays at the BIBB starting in 2015. Of particular interest from a German standpoint are the development of occupation profiles (for example for environmental technology occupations), the definition of evaluation criteria for best-practice pilot projects and the evaluation of the work performed in previous and existing cooperation activities.

→ **Measure 35: Promoting the export of German services in vocational education and training**

Support for German initial and further education and training providers via marketing measures under the iMOVE programme and the funding priority for the export of VET play a significant role in Germany's VET activities in China. Given the continued strong demand for VET services made in Germany, China will remain a key target country for German-based education providers.



## 5.10 Overview of cooperation measures

No.	Measure	Description	Focus
<b>Creating a better China expertise in Germany</b>			
1	Promoting innovative approaches for expanding China expertise at German higher education institutions	<ul style="list-style-type: none"> <li>• Competition to strengthen China expertise among German students and (young) scientists by means of pooling and developing China-related activities at German higher education institutions</li> </ul>	Fostering China experience
2	Promoting long-term study and research stays in China	<ul style="list-style-type: none"> <li>• Comprehensive funding of longer study and research stays for German students, post-graduates and doctoral students in China by both sides</li> </ul>	Individual measure; fostering China experience; meeting demand for skilled workers
3	Establishing a China-focused monitoring system tailored to the needs of stakeholders in science and research	<ul style="list-style-type: none"> <li>• Regular evidence-based and target-group focused monitoring of current developments and trends in Chinese research policy</li> <li>• Information-gathering events, including with Chinese partners</li> <li>• Needs-based commission of studies to consolidate the findings of China-related monitoring activities</li> <li>• Workshops and fact-finding missions to link experts and explore the Chinese research landscape</li> </ul>	Information gathering and provision
<b>Building sustainable cooperation structures and researcher networks</b>			
4	Promoting structural strategic cooperation activities in higher education	<ul style="list-style-type: none"> <li>• Funding of structural cooperation activities, for example in expanding strategic and model partnerships</li> <li>• Discussion with the MoE of the establishment of joint dual degrees and doctoral programmes</li> </ul>	Structural measure; fostering China experience; bilateral research cooperation; meeting demand for skilled workers
5	Intensifying activities of the Sino-German College for Applied Sciences	<ul style="list-style-type: none"> <li>• Intensify cooperation with partner institutes (Sino-German College for Graduate Studies and Sino-German Institute for Vocational Education and Training) under the roof of the Sino-German University</li> <li>• Increase the number of German students who spend a year's study at the Sino-German College for Applied Sciences</li> </ul>	Structural measure; fostering China experience; bilateral research cooperation; meeting demand for skilled workers
6	Promoting sustainable research cooperation between German and Chinese higher education institutions and research institutes	<ul style="list-style-type: none"> <li>• Establish and use laboratories and other research infrastructure at Chinese higher education institutions to achieve joint research results on mastering global challenges and train research staff</li> <li>• Bilateral implementation of the measure by the BMBF and the MoE</li> </ul>	Structural measures
7	Establishing an alumni network	<ul style="list-style-type: none"> <li>• Alumni activities for German and Chinese alumni to ensure sustainability of expertise and contacts</li> <li>• Supporting access of German science to Chinese alumni</li> </ul>	Alumni work; exchange and networking
<b>Networking German stakeholders and designing policy dialogues</b>			
8	Intensifying exchange with German research, funding and intermediary institutions, higher education institutions and other ministries	<ul style="list-style-type: none"> <li>• Regular meetings of the 'China round table' at the BMBF dealing with current developments in Chinese research and education policy, and offering an opportunity for the exchange of cooperation experiences, best-practice examples and cooperation difficulties</li> <li>• Participation at thematically relevant meetings called by the German Federal Foreign Office and other ministries</li> <li>• Ongoing contact with science counsellors at the German embassy and consulates in China</li> </ul>	Exchange and networking
9	Designing the bilateral policy dialogue mechanisms in education, science, research and innovation	<ul style="list-style-type: none"> <li>• Contribute to the BMBF-MoST established bilateral dialogue mechanisms (Joint S&amp;T Commission, thematic Steering Committees)</li> <li>• Contribute to the BMBF-MoE established bilateral dialogue mechanisms (Strategy Dialogue on Education Policy, German-Chinese Alliance for Vocational Education and Training)</li> <li>• Contribute to German-Chinese intergovernmental consultations</li> <li>• Where appropriate, develop further dialogue mechanisms with other Chinese stakeholders in the education, research and innovation system</li> </ul>	Policy dialogue

No.	Measure	Description	Focus
<b>Networking German stakeholders and designing policy dialogues</b>			
10	Participating in European and international bodies and initiatives relating to education and research cooperation with China	<ul style="list-style-type: none"> <li>Participate in the China initiative of the Strategic Forum for International Science and Technology Cooperation (SFIC)</li> <li>Participate in EU research cooperation projects with China conducted under Horizon 2020</li> <li>Discussion of possible participation of EU Member States' representatives at meetings of the Joint Steering Committee on Science and Technology hosted by the EU Commission and MoST</li> <li>Represent position on cooperation activities with China in the EU programme committees</li> <li>Participate in China-related activities of international organisations</li> <li>Support greater coordination between the science counsellors at the various EU Member State embassies in Beijing</li> </ul>	Policy dialogue; development of framework conditions
<b>Optimising conditions for German science and research engagement in China</b>			
11	Intensifying the dialogue with China on framework conditions for research and education cooperation	<ul style="list-style-type: none"> <li>Discuss the conditions needed to ensure fair competition, fair market conditions for foreign businesses and the protection of intellectual property</li> <li>Use of the Sino-German Innovation Platform for dialogue purposes</li> <li>Discuss the framework conditions for higher education cooperation</li> <li>Identify further contacts in addition to MoST and MoE</li> </ul>	Policy dialogue; development of framework conditions
12	Intensifying exchange with responsible German ministries and bodies regarding standards and certification	<ul style="list-style-type: none"> <li>Intensify exchange with the BMWi, the German Institute for Standardization, the Asia-Pacific Committee of German Business, etc.</li> </ul>	Exchange and networking; development of framework conditions
<b>Promoting key technologies</b>			
13	Further developing the Sino-German Strategic Platform for Electric Mobility	<ul style="list-style-type: none"> <li>Annual meetings to develop a cross-ministerial strategic approach to German-Chinese cooperation on electric mobility</li> </ul>	Exchange and networking; development of framework conditions; bilateral research cooperation
14	Implementing R&D projects for LED technology use	<ul style="list-style-type: none"> <li>Conduct further joint R&amp;D projects on the use of LED technology (e.g. in agriculture, schools and municipalities)</li> </ul>	Exchange and networking; development of framework conditions; bilateral research cooperation
15	Exploring opportunities for an innovation partnership between China's and Germany's digital industries	<ul style="list-style-type: none"> <li>Explore opportunities for an innovation partnership between the Chinese and German digital industries</li> <li>BMBF delegation visit to China</li> </ul>	Exchange and networking; development of framework conditions
<b>Promoting the life sciences</b>			
16	Implementing a pilot project to promote industry-led collaboration projects on biomaterials using the '2+2 model'	<ul style="list-style-type: none"> <li>Promote industry-led collaboration projects</li> <li>Create a joint database to present life science institutions and stakeholders from German and Chinese industry and research</li> </ul>	Information gathering and provision; bilateral research cooperation
17	Continuing the funding programme 'Bioeconomy International'	<ul style="list-style-type: none"> <li>Promote German-Chinese cooperation in all disciplines of bioeconomy</li> <li>Identify and classify areas for bilateral cooperation under the 'National Research Strategy Bioeconomy 2030' and the Internationalisation Strategy</li> <li>Identify potential for future 2+2 cooperation activities</li> </ul>	Bilateral research cooperation

No.	Measure	Description	Focus
<b>Mastering global environmental challenges</b>			
18	Supporting German industry in distributing innovative environmental/water technologies adapted to Chinese needs	<ul style="list-style-type: none"> <li>Establish the 'Clean Water' Innovation Centre in Shanghai</li> <li>Distribute innovative technologies, such as the SEMIZENTRAL water supply and wastewater disposal plant, in China</li> </ul>	Exchange and networking; bilateral research cooperation
19	Continuing the bilateral Research and Innovation Programme 'Clean Water' (CLIENT/FONA3 Framework Programme) in cooperation with MoST	<ul style="list-style-type: none"> <li>Coordination and announcement of a new call for proposals on clean water</li> </ul>	Bilateral research cooperation
20	Supporting Chinese participation in the BMBF Science Year 'City of the Future'	<ul style="list-style-type: none"> <li>Joint events on urbanisation/city of the future, such as the 'Sustainable Urbanisation Conference' in China</li> </ul>	Exchange and networking
21	Setting-up a call for proposals on 'Sustainable Urban Regions' which is also open to Chinese-German consortia	<ul style="list-style-type: none"> <li>Implementation of a call for proposals on 'Sustainable Urban Regions' in which Chinese-German project consortia may apply (preference will be given to climate change adaptation measures and strategies to prevent greenhouse gases)</li> </ul>	Bilateral research cooperation
22	Promoting exchange of young German and Chinese researchers and students in the field of renewable energies	<ul style="list-style-type: none"> <li>Joint workshops involving German and Chinese representatives from policymaking, industry and science</li> <li>Identification of potential areas for cooperation and corresponding measures</li> </ul>	Exchange and networking
23	Implementing scientific accompanying research on the impacts of large-scale energy infrastructure projects on environment and nature	<ul style="list-style-type: none"> <li>Implementation of joint German-Chinese accompanying research projects on the impacts of large-scale energy infrastructure projects on the environment and nature (grid expansion, pump-water storage, hydropower)</li> </ul>	Bilateral research cooperation
24	Acquiring more knowledge on the status of renewable energy research in China	<ul style="list-style-type: none"> <li>Development of an overview of excellence in renewables at research institutes in China (Chinese map of excellence in energy research) in cooperation with Chinese partners</li> <li>Identifying and evaluating existing German-Chinese technology cooperation as well as renewables-based collaboration between the EU Member States and China</li> </ul>	Information gathering and provision
25	Preparing a status report on the strengths and weaknesses of Chinese climate research to identify potential areas for future cooperation	<ul style="list-style-type: none"> <li>Obtain a systematic overview of the current status and the expected developments in climate research in China</li> <li>Exchange and coordination of information at EU level</li> </ul>	Information gathering and provision
26	Continuing the long-standing, intensive marine and polar research cooperation with the State Oceanic Administration	<ul style="list-style-type: none"> <li>Conduct bilateral workshops to assess the need for further calls for proposals (for example, in marine raw materials research)</li> </ul>	Information gathering and provision; exchange and networking; bilateral research cooperation
27	Intensifying cooperation in natural disaster and georisk research, and the development of monitoring and early-warning systems	<ul style="list-style-type: none"> <li>Identify further areas for cooperation</li> </ul>	Information gathering and provision; bilateral research cooperation

No.	Measure	Description	Focus
<b>Promoting the humanities and social sciences</b>			
28	Promoting social science cooperation with China in broader-based project funding lines	<ul style="list-style-type: none"> <li>Funding of cooperation activities with China along a new project funding line as part of the current framework programme 'Humanities, Cultural and Social Sciences'</li> <li>Cooperation with other disciplines and intra- and inter-university networking</li> </ul>	Bilateral research cooperation
29	Establishing an International Centre for Advanced Studies in the Humanities and Social Sciences in China	<ul style="list-style-type: none"> <li>Interdisciplinary research on jointly selected key topics by German and Chinese researchers</li> <li>Academic exchange between Germany and China</li> </ul>	Bilateral research cooperation; exchange and networking
<b>Intensifying cooperation in vocational education and training</b>			
30	Intensifying cooperation in quality assurance	<ul style="list-style-type: none"> <li>Support the MoE in defining evaluation criteria for best-practice pilot projects in accordance with the five core principles of the German VET system</li> <li>Emphasise the need for standards for quality assurance and support Germany's excellent VET reputation in China</li> </ul>	Consultation
31	Developing regional partnerships in cooperation on vocational education and training	<ul style="list-style-type: none"> <li>Take a demand-focused approach to boosting cooperation with specific regions</li> <li>Lighthouse projects for company-oriented VET approaches in selected Chinese regions</li> <li>Project identification via fact-finding measures and ensuring the participation of German companies in project development</li> </ul>	Consultation; structural measure; exchange and networking; meeting the demand for skilled workers
32	Providing assistance in the implementation of dual structures via the VETnet project	<ul style="list-style-type: none"> <li>Advice in embedding dual components into the Chinese VET system, e.g. the work-based component with involvement of the relevant trade chambers in addition to the school-based component</li> <li>Promoting the German Chamber of Commerce (AHK) as a contact for Chinese partners especially at regional level, for example in the certification of pilot projects in accordance with the dual principles</li> </ul>	Consultation; structural measure; exchange and networking
33	Networking German stakeholders via an integrated project and alumni database	<ul style="list-style-type: none"> <li>Improved networking between individual stakeholders in VET</li> <li>Linking the databases operated by GOVET (project database), iMOVE (database for VET providers) and the GIZ (VET measures, including an alumni portal)</li> </ul>	Structural measure; exchange and networking
34	Establishing sustainable cooperation between the Federal Institute for Vocational Education and Training and Chinese partners	<ul style="list-style-type: none"> <li>Dialogue with relevant Chinese research institutes to (further) develop and evaluate potential models for VET transfer for China</li> <li>Joint research and mutual exchange of information, e.g. to develop occupation profiles and evaluation criteria for best practice pilot projects</li> <li>Research stays for Chinese researchers at the Federal Institute for Vocational Education and Training (BIBB)</li> </ul>	Consultation; structural measure; exchange and networking
35	Promoting the export of German services in vocational education and training	<ul style="list-style-type: none"> <li>Support for German providers of initial and further education and training via marketing measures under the iMOVE programme and the funding priority of VET export</li> </ul>	Exchange and networking



## 6. Annex

### A. Overview of key Chinese research and education programmes

Programme	Thematic priorities/goals	Budget 2012 and number of people/ higher education institutions
National High Technology R&D Program (863 Program)	Promotion of selected high technologies, including ICT, biotechnology, materials research and energy	RMB 5.5 billion [approx. EUR 667 million]
R&D Infrastructure and Facility Development Program	Improving the R&D infrastructure for China's research community in the public and private sector	RMB 265 million [approx. EUR 32 million]
National Key Technology R&D Program	Focus on key technologies for the modernisation of industry and agriculture, development of technologies for environmental protection, sustainable development and improved living conditions for the population	RMB 6.4 billion [approx. EUR 787 million]
National Basic Research Program (973 Program)	Basic research in agriculture, energy, ICT, materials research, environment and resources, population and health	Approx. RMB 4 billion [approx. EUR 492 million] (together with National Science and Technology Major Projects)
Spark Program	Rural development	No data available
Torch Program	Development of high-tech industries via science parks and start-up incubators	No data available
Thousand Talents Program	Recruitment of well-established academics and entrepreneurs from abroad using attractive salaries, start-up packages and tax incentives	Some 3,300 people recruited (figure valid: summer 2013)
211 Program	Selection and funding for the 100 best higher education institutions for the 21st century	112 institutions funded (figure valid: March 2012)
985 Program	Funding of selected higher education institutions already funded under the 211 Program and their transition to globally recognised elite universities	39 institutions funded (figure valid: March 2012)
C9 League	Merging of nine universities promoted under the 985 Program. In 2010, the C9, which together only have about three percent of the nation's research staff, received ten percent of overall state expenditure for R&D.	Beijing, Tsinghua, Fudan, Shanghai Jiao Tong, Nanjing, Zhejiang, Xi'an Jiao Tong University, University of Science and Technology of China, Harbin Institute of Technology

Source: BMBF.

## B. China-related activities of selected EU Member States

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The three countries listed below provide important examples of cooperation with China. However, these represent only some of the numerous collaborative relationships and activities between EU Member States and China in the research sector. Almost all EU Member States now cooperate with China in education and research. It is thus important for EU Member State activities with China to be carefully coordinated – both in Brussels and between the science counsellors at the respective Member State embassies in Beijing.

### United Kingdom

The United Kingdom (UK) and China signed an agreement on science and technology cooperation in 1978. Most recently, they declared their great interest in intensifying cooperation in education and research in a joint declaration issued in June 2014 by Prime Minister David Cameron and Prime Minister Li Keqiang.<sup>23</sup>

The UK-China Research and Innovation Partnership Fund<sup>24</sup> established in 2014 by the UK Department for Business Innovation and Skills is part of the UK's Newton Funds programme to promote science and innovation in emerging knowledge economies. The UK-China Research and Innovation Partnership Fund was designed to promote cooperation in the fields of health, environmental technologies, food and water, urbanisation, energy, education and creative industry. Over the next five years, the UK and China plan to spend some £200 million (approximately EUR 253 million) for new activities aimed at promoting mobility among scientists, joint research projects and broader-based innovation partnerships. Apart from the MoST and the MoE, partners on the Chinese side include the NSFC of China and several Chinese academies.

In a first step towards implementing the UK-China Research and Innovation Partnership Fund, the UK and China announced the Climate Science for Service Partnership China, various research partnerships in marine

energy, regenerative medicine and stem cell research, the effects of air pollution on human health, soil ecosystem conservation and Newton Fellowships for scientists from both countries. In spring 2015, the British Economic and Social Research Council and the NSFC of China issued a joint call for proposals on urban transformations in China.

The Science and Innovation Network which is jointly funded by the UK Department for Business Innovation & Skills and the UK Foreign & Commonwealth Office supports the Newton Fund with a broad-based programme. This programme is managed by the Science and Innovation Network coordinators located at the British embassy in Beijing and at the British consulates in Chongqing, Guangzhou and Shanghai in cooperation with the Research Councils and the British Council.

### Finland

Finland sees China as a priority country in international cooperation. The foundation for Finnish-Chinese cooperation was laid in the mid-1980s. Since then, a range of bilateral framework agreements have been signed in education, research and innovation. The Finnish Ministry of Education, Science and Culture began cooperation activities with the MoE in 2009, the MoST in 2012 and the Chinese Academy of Social Sciences in 2014.

The Finnish Ministry of Economic Affairs' China Strategy developed in 2012 by Tekes (Finland's top public funding agency for technology and innovation, which has two offices in China), lists ICT, the environment and energy as joint cooperation topics.<sup>25</sup>

For many years, Finnish-Chinese cooperation has placed considerable focus on research in ICT, education, teaching and learning. The China-Finland ICT Alliance established in 2009 serves as a cooperation platform for a range of ICT-focused research institutions and companies.

Cooperation between the Academy of Finland (the Finnish funding agency for pioneer research) and the Chinese Academy of Sciences (CAS) and the NSFC takes

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<sup>23</sup> UK Foreign & Commonwealth Office (17 June 2014).

<sup>24</sup> UK Department for Business, Innovation & Skills (17 June 2014).

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<sup>25</sup> Tekes (2012).



in all research disciplines with exception of the social sciences, the humanities and cultural sciences, in which cooperation is conducted with the Chinese Academy of Social Sciences. Up to now, the Academy of Finland has issued a number of joint calls for proposals with the NSFC (in 2010 and 2011 in conjunction with the DFG). This year's call for proposals which is in the telecommunications field concerns 5G networks.

Under the agreement signed in 2014 between the Finnish Ministry of Education, Science and Culture and the Chinese Academy of Social Sciences, all 14 Finnish universities are seeking to intensify their cooperation activities. The vast majority of Finnish universities and research institutes already cooperate with Chinese partner organisations.

The Sino-Finnish Centre is located at the Aalto-Tongji Design Factory on the Tongji University campus in Shanghai. It offers interdisciplinary, cross-border courses and workshops in product design, eco-innovation and business management, and involves companies in these activities.

The China Education and Research Centre established at Tampere University in 2011 and the Finland Education and Research Centre at Beijing Normal University cooperate via the Sino-Finnish Learning Garden – a network which links stakeholders from education research, pedagogy and education management and provides training programmes in the administration of education institutes.

## France

Research cooperation between France and China is based on an agreement signed in January 1978 between the respective ministries of foreign affairs. At a meeting of the joint science committee in May 2011, the following topics were agreed as priority research fields: sustainable development, biodiversity, water management, green technology, energy, health (including infectious diseases) and ICT (including smart cities). The French Ministry for Tertiary Education and Research published a strategy paper<sup>26</sup> on science and technology cooperation with China in 2011. The paper highlights the need to improve networking and coordination of activities between French stakeholders and to make use of experience gained by China alumni and scientists who have worked in China.

Along with joint laboratories, research programmes and mobility projects, the main cooperation instruments include representations of large French research organisations in China, such as the Centre national de la recherche scientifique, the Commissariat à l'énergie atomique et aux énergies alternatives, the Institut national de la santé et de la recherche médicale, the Institut national de la recherche agronomique, the Centre international pour la recherche agronomique pour le développement and the Institut Pasteur. French universities are also increasing their own presence in China and are setting up offices there.

More than 2,900 scientists from France and China cooperate in more than 600 research groups. About four new joint research structures have been established each year since 2004. A shining example of Chinese-French cooperation is the Laboratoire franco-chinois d'Informatique, d'Automatique et de Mathématiques Appliquées, a joint laboratory operated by the Institut National de Recherche en Informatique et en Automatique and the Institute of Automation at the Chinese Academy of Sciences.<sup>27</sup>

The research funding agencies in both countries also work in close cooperation. France's Agence National de la Recherche has co-financed 53 bilateral projects with a combined budget of EUR 14.5 million together with the MoST and the NSFC. The MoST also cooperates with the Banque publique d'investissement France to promote industrial research cooperation between French and Chinese SMEs.

With approximately 30,000 Chinese students and young researchers at universities and institutes of higher education, the Chinese are the second-biggest group of overseas students in France. To promote mobility, various bilateral mobility programmes have been launched, among them the Hubert Curien Partnerships which on the French side are financed by the Ministry of Foreign Affairs and the Ministry for Education, Tertiary Education and Research.

26 Ministère de l'Enseignement supérieur et de la Recherche (November 2011).

27 France diplomatie (20 March 2014).

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## E. Abbreviations

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AHK	Außenhandelskammer (German Chamber of Commerce)
AvH	Alexander von Humboldt-Stiftung (Alexander von Humboldt Foundation)
BEIBU	Project: Holocene environmental evolution and anthropogenic impact of Beibu Gulf, South China Sea
BIBB	Bundesinstitut für Berufsbildung (Federal Institute for Vocational Education and Training)
BMBF	Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research)
BMUB	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety)
BMVI	Bundesministerium für Verkehr und digitale Infrastruktur (Federal Ministry for Transport and Digital Infrastructure)
BMW	Bundesministerium für Wirtschaft und Energie (Federal Ministry for Economic Affairs and Energy)
CAE	Chinese Academy of Engineering
CAS	Chinese Academy of Sciences
CASS	Chinese Academy of Social Sciences
CDC	Chinesisch-Deutscher Campus (Sino-German Campus) at Tongji University
CDH	Chinesisch-Deutsche Hochschule (Sino-German University) at Tongji University
CDHAW	Chinesisch-Deutsche Hochschule für Angewandte Wissenschaften (Sino-German College for Applied Sciences) at Tongji University
CDHK	Chinesisch-Deutsches Hochschulkolleg (Sino-German College for Graduate Studies) at Tongji University
CDIBB	Chinesisch-Deutsches Institut für Berufsbildung (Sino-German Institute for Vocational Education and Training) at Tongji University
CLIENT	Programme: International Partnerships for Sustainable Technologies and Services for Climate Protection and the Environment
CSC	China Scholarship Council
DAAD	Deutscher Akademischer Austauschdienst (German Academic Exchange Service)
DELIGHT	Project: Delta Information System for Geoenvironmental and Human Habitat Transition
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
EFI	Expertenkommission Forschung und Innovation (Commission of Experts for Research and Innovation)
ERTC	Exploratory Round Table Conferences
EU	European Union
FhG	Fraunhofer Gesellschaft
FONA	Programme: Forschung für Nachhaltige Entwicklung (Research for Sustainable Development)
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOVET	German Office for International Cooperation in Vocational Education and Training
GTAI	Germany Trade and Invest
HAPPI	Project: Small Hydropower Plants: Assessment of Climate Protection Potential and Improvement by Smart Technologies

HGF	Helmholtz-Gemeinschaft Deutscher Forschungszentren (Helmholtz Association of German Research Centres)
HRK	Hochschulrektorenkonferenz (German Rectors' Conference)
ICT	Information and Communications Technology
iMOVE	International Marketing of Vocational Education
IPR	International Property Rights
ISO	International Organization for Standardization
IT	Information Technology
KfW	Kreditanstalt für Wiederaufbau (KfW Development Bank)
LANCET	Project: Land-Sea Interactions along Coastal Ecosystems of Tropical China: Hainan
LED	Light-Emitting Diode
LOGinCHINA	International Logistics Management China
MIIT	Ministry of Industry and Information Technology
MoE	Ministry of Education
MoST	Ministry of Science and Technology
MPG	Max-Planck-Gesellschaft (Max Planck Society)
NDRC	National Development and Reform Commission
NPC	National People's Congress
NSFC	National Natural Science Foundation
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PICB	CAS-MPG Partner Institute for Computational Biology
PPP	Purchasing Power Parity
PROSAWA	Projektbüro Sauberes Wasser (Project Office 'Clean Water')
RCEIS	Research Centre for Environmental Information Science
RMB	Renminbi (official currency of the People's Republic of China)
R&D	Research and Development
SEMIZENTRAL	Project: Semizentrale Ver- und Entsorgungssysteme für schnellwachsende urbane Räume (Semicentralized supply and treatment systems for fast-growing urban areas)
SFIC	Strategic Forum for International S&T Cooperation
SME	Small and Medium-Sized Enterprise
SSL	Solid state lighting
STI	Science, Technology and Innovation
SWOT	Analysis methodology: Strengths, Weaknesses, Opportunities, Threats
S&T	Science and Technology
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States of America
USD	US Dollar
VET	Vocational Education and Training
VETnet	Project: German chambers worldwide network for cooperative, work-based vocational education and training
WAYS	Project: Future Technologies and Services for Water and Resources Management at the Upper Yangtse River, Sichuan Province, China
WHO	World Health Organization

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