



Roadmap for EU-China S&T cooperation

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1. CHINA AS A PARTNER OF THE EU

Since the establishment of diplomatic relations between the EU and the People's Republic of China in 1975, China has undergone a tremendous economic, social and technological development. EU-China relations were upgraded to a Comprehensive Strategic Partnership in 2013 and now span a wide range of areas diversifying the relationship from its initial economic focus.

1.1. Economic Outlook

With the GDP growth rate at 6.9% in 2017 and 6.8% in the first half of 2018, China continued to stress quality of growth over quantity as set out in the 13th Five-year Plan on National Economy and Social Development (2016-2020), which consolidated the national objective to pursue an innovation-driven development strategy.

China is the world's third largest economy after the EU and the USA. In 2013 China overtook the USA as the second biggest trader after the EU. In terms of Purchasing Power Parities (PPPs), i.e. adjusted for the price level, China is already the largest economy in the world (China: 23.2 trillion USD; EU: 20.9 trillion USD; US: 19.4 trillion USD). China has been the world's fastest growing major economy, with consistent growth rates of around 10% over the past 30 years and its per capita income in PPPs has risen from 3.5% of the USA in 1980 to 37.9% in 2017.

The EU is China's biggest trading partner. China is the EU's second biggest trading partner after the USA. The EU is one of the top-five sources of foreign direct investment (FDI) to China. In 2016, Chinese FDI hit an all-time high at global and EU levels. According to a 2017 Merics report, the EU attracted 35 billion EUR in completed Chinese FDI transactions in 2016, corresponding to a 77% increase compared to 2015 levels. EU FDI to China, by contrast, continued to decrease to 8 billion EUR, down from 9.1 billion EUR in 2015 and 11.8 billion EUR in 2014.

1.2. EU-China Summits and Innovation Cooperation Dialogues

During the 20th EU-China summit held on 16 July 2018 in Beijing, the EU and China agreed to further develop the EU-China strategic partnership. Recalling that 2018 marked the 20th Anniversary of the signature of the EU-China Science and Technology Cooperation Agreement, the two sides welcomed recent progress in these areas, and through the EU-China Joint Steering Committee on Science and Technology Cooperation, the EU-China Innovation Cooperation and EU-China Space Cooperation Dialogues. The two sides declared they would jointly implement the 2018-2020 Flagship Initiatives and explore a roadmap for further cooperation in areas such as basic research, frontier science and key societal challenges, building on the Co-Funding Mechanism. The EU and China aim to improve the framework conditions for cooperation on innovation and promote more mutually beneficial, open and equal science, technology and innovation cooperation. In the joint statement, EU and

Chinese leaders also referred to climate change and clean energy. They agreed to enhance their collaboration on climate-related scientific research and cooperation on technology innovation, including the development and deployment of low greenhouse gas emission technologies such as carbon capture, utilisation and storage (CCUS), and adaptation solutions. Moreover, the two sides committed to further strengthening exchanges and cooperation including in the fields of education and mobility of researchers.

The 19th EU-China Summit that took place on 2 June 2017 in Brussels was particularly important as it provided the opportunity for EU and China leaders to reaffirm the importance of cooperation in the area of research and innovation as a driver for economic and social development, and a key element of EU-China relations. Two research and innovation related documents were signed notably: a Joint Statement on flagship initiatives and co-funding mechanisms, and a Framework Research Arrangement between the European Commission Joint Research Centre (JRC) and the Chinese Academy of Sciences (CAS).

At the 3rd EU-China Innovation Cooperation Dialogue (ICD) organised in the margins of the Summit, the EU and China agreed to boost their cooperation with a new package of flagship initiatives targeting the areas of food, agriculture and biotechnologies, environment and sustainable urbanisation, surface transport, safer and greener aviation, and biotechnologies for environment and human health. These initiatives have been translated into a number of topics for cooperation with China under Horizon 2020. Both sides agreed on the renewal of the EU-China co-funding mechanism for research and innovation for the period 2018-2020, and confirmed their commitment to improving framework conditions, notably reciprocal access to science, technology and innovation resources, and to promoting open access to publications and research results.

1.3. EU-China non-S&T cooperation agreements

EU-China relations are guided by the annual Summit and the high level dialogues underpinning it such as the High-Level Strategic Dialogue launched in 2010, the annual High-Level Economic and Trade Dialogue launched in 2010, the High-Level People-to-People Dialogue established in 2013, and the High-Level Innovation Cooperation Dialogue (ICD) inaugurated in 2013.

The EU-China 2020 Agenda for Strategic Co-operation, adopted at the 2013 Summit, is currently the defining document for the bilateral relationship. Addressing the broad headings of peace and security, prosperity and sustainable development and people-to-people exchanges, it contains extensive reference to the pivotal role of research and innovation cooperation in the overall EU-China relations.

1.4. EU-China S&T cooperation agreements and ICD

EU-China scientific cooperation is governed by a Science and Technology Cooperation Agreement signed in December 1998 and renewed for the third time in December 2014. The implementation of the Agreement is

overseen by a Joint Steering Committee which last met on 29 March 2017 in Brussels and is scheduled to meet on 13 December 2018 in Beijing.

The importance of China as a key partner country has been confirmed by the Commission decision to set up a dedicated High-Level Innovation Cooperation Dialogue (ICD) through a joint declaration signed in September 2012 by then EU Commissioner Maire Geoghegan-Quinn and Chinese Minister Wan Gang. The ICD has the ambition of raising the level and intensity of research and innovation relations with China by providing a forum for discussion respective innovation policies and systems, addressing framework conditions and launching new joint Research and Innovation (R&I) initiatives.

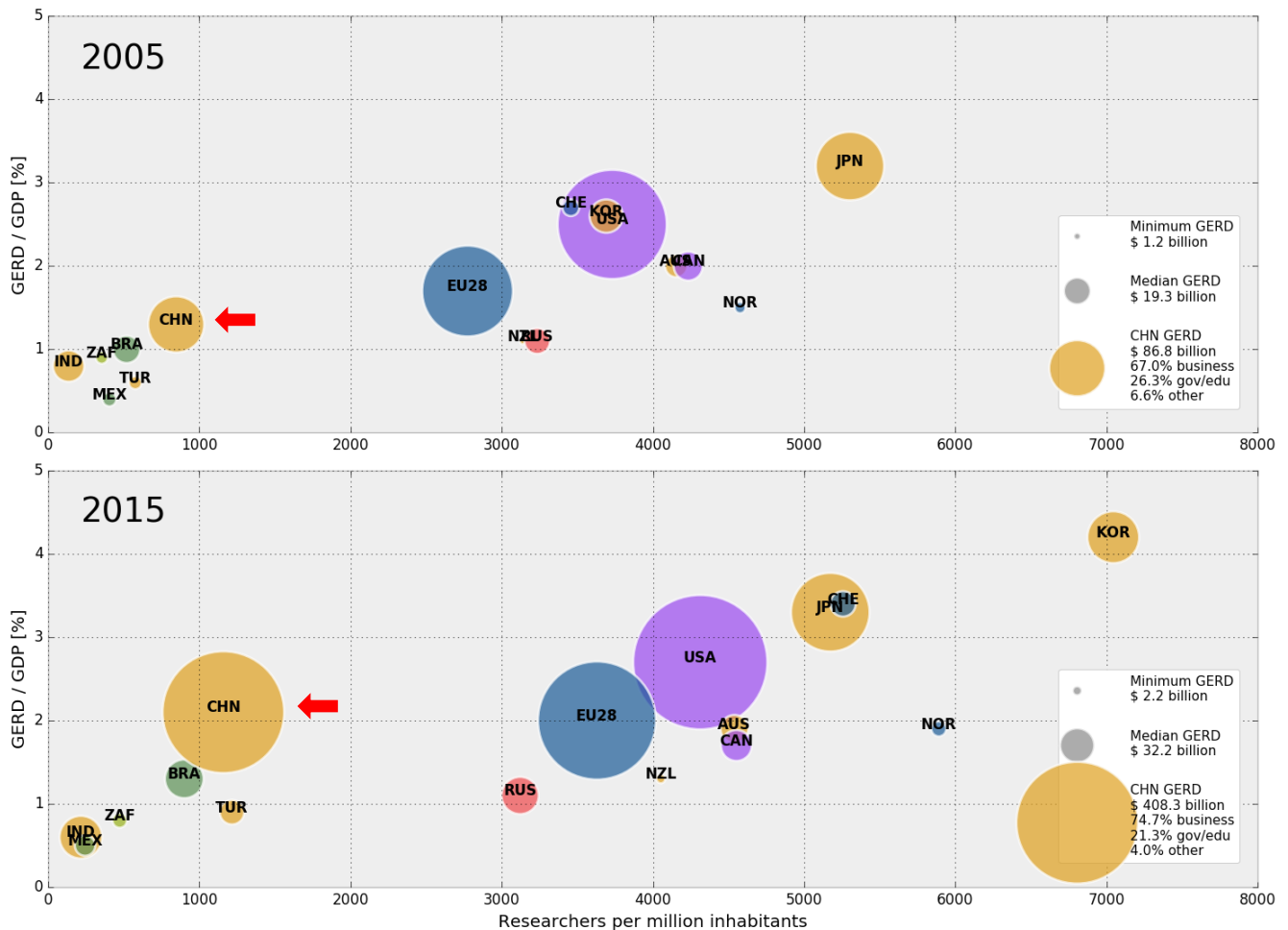
In addition an Agreement between the European Atomic Energy Community (Euratom) and the Government of the People's Republic of China for Research and Development (R&D) Cooperation in the Peaceful Uses of Nuclear Energy (RD-PUNE) is in place since August 2008. China and Euratom are participating in an inter-governmental multilateral agreement on fission-related research, are partners of the ITER multilateral cooperation project on fusion research and participate, within the Generation IV international Forum, in the research and development activities of the Sodium Fast Reactor and the Very-High Temperature Reactor.

1.5. R&I landscape in China

The 13th Five-Year Plan on Science and Technology Innovation (STI) published in August 2016 called for increased STI funding and further reform of the national S&T funding system. International cooperation is given a prominent role, which creates more opportunities for strengthening EU-China STI cooperation. The National People's Congress convened in March 2018 continued to underline the commitment in pursuing the Innovation-driven development strategy for an innovative and competitive economy.

In terms of R&D spending, China's total expenditures in 2017 were worth RMB 1.75 trillion (EUR 222.7 billion), 11.6% year-on-year increase, accounting for 2.12% of GDP (anticipated to reach to 2.16% in 2018). By 2020, China plans to boost its R&D intensity to 2.5% and reach an S&T contribution to economic growth of 60%. Of the total R&D spending, industry was responsible for 77.5% while universities and government-funded research institutions accounted for 6.8% and 14.4% respectively. Mass innovation and entrepreneurship are being strengthened through a range of measures. New profit sharing schemes are put in place to allow scientists to retain profits from their innovations. Measures were released to strengthen research integrity and curb academic fraud. Moreover, the evaluation of projects, researchers and institutions will be reformed to streamline and improve the mechanisms for evaluating scientific research projects and academic performance of researchers and research institutes.

Figure 1: Expenditures in Research & Development and researchers per million inhabitants



Note: GERD in current PPP; Top chart: Data for CHE from 2004. Bottom chart: Data on researchers per million inhabitants for BRA from 2014, for CAN from 2014, for MEX from 2013 and for AUS from 2010.
 Source: DG RTD - International Cooperation
 Data: UIS, OECD, EUROSTAT; extraction date: 11/10/2018

International collaboration continues to play an important role to strengthen China's STI capacity and to jointly tackle global societal challenges. EU-China relations in research and innovation have experienced a boost over the past years. At the 3rd Innovation Cooperation Dialogue (ICD) in the margins of the 19th EU-China Summit, both sides have agreed to boost cooperation with a new package of flagship initiatives targeting the areas of food, agriculture and biotechnologies, environment and sustainable urbanisation, surface transport, safer and greener aviation, and biotechnologies for environment and human health. Both sides also agreed on the renewal of the EU-China co-funding mechanism for research and innovation (CFM) for the period 2018-2020, and confirmed their commitment to improving framework conditions, notably reciprocal access to Science and Technology and Innovation resources, and to promoting open access to publications and research results. China

has been actively promoting its Belt and Road Initiative and has further institutionalized its STI cooperation with international partners.

The National Innovation Index 2016-2017 released by the Chinese Academy of Science and Technology for Development on 18 August 2017 showed that China's R&D expenditure accounts for 15.6% of the world's total. Based on the statistics of the Science, Research and Innovation Performance of the EU 2018, China's share of world R&D expenditure increased from 5 % in 2000 to 21 % in 2015 (from 25% to 20% for the EU over the same period).

In the Global Innovation Index by Cornell University and WIPO, China was listed among the top 20 most innovative economies among the 126 economies, ranking the 17th from the 22nd of last year. Switzerland, Luxembourg and China are the top three in translating investment in education, research and R&D expenditures into high-quality innovation outputs.

China is the world's second largest publisher of research and remains the 3rd in the number of high-citation papers. The Nature Index 2018 shows that Chinese institutions continue to rise with the Chinese Academy of Sciences (CAS) topping the world's leading institutions for high-quality scientific research. Sixteen Chinese institutions are placed among the leading 100 academic institutions.

The latest statistics of the World Intellectual Property Organisation (WIPO) showed that China ranked second in international patent applications and is expected to overtake the US in three years as the largest source of applications filed under the Patent Cooperation Treaty.

2. STATE OF PLAY OF EU-CHINA S&T COOPERATION

2.1. Statistics on on-going FP7 and Horizon 2020 cooperation

Overall in Horizon 2020 until October 2018 Chinese entities have participated 337 times to 158 signed grants of collaborative, Marie Skłodowska-Curie Actions (MSCA) and European Research Council (ERC) actions, receiving 3.1 million EUR of direct EU contribution while 33.8 million EUR is the non-EU budget of Chinese beneficiaries. Regarding collaborative actions¹ of Horizon 2020, Chinese applicants are involved 1052 times (2 times as coordinators) in 441 eligible proposals. Out of 252 high-quality (above threshold) proposals, 87 were mainlisted, leading to a success rate of 19.7% (as compared to 17.5% for non-associated countries and 15.8% overall). Chinese entities have **183 participations** (181 times as beneficiaries) **in 78 signed grants**, receiving 3.0 million EUR from EU while 33.8 million EUR is the non-EU budget of Chinese beneficiaries.

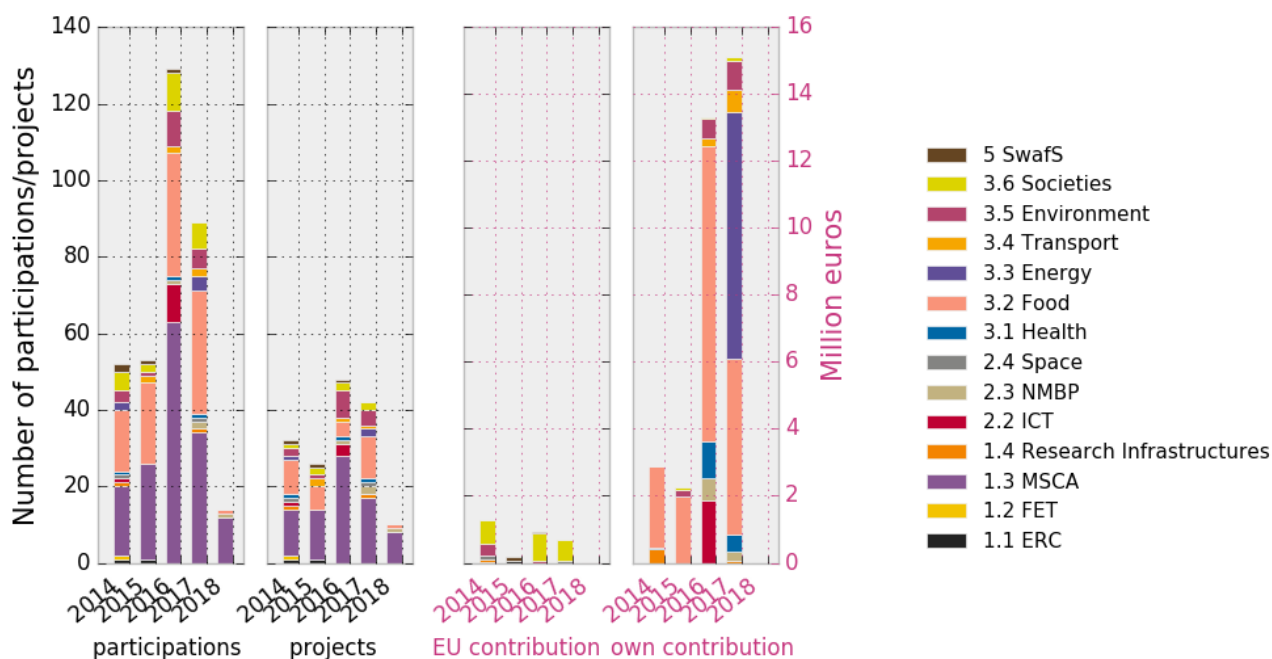
¹ i.e. excluding projects under ERC, MSCA, SME Instrument and Access to Risk Finance.

Regarding MSCA, Chinese applicants are involved 663 times in 437 eligible proposals. Out of 333 high-quality proposals (above threshold), 81 were mainlisted. **Chinese entities have participated 152 times in MSCA actions** (2 in Individual Fellowships, 117 in the RISE, 25 in the ITN and 8 in the COFUND programme). **A total of 904 researchers of Chinese nationality have participated in MSCA actions.** Regarding ERC grants, **Chinese entities have participated 2 times to signed ERC grants**, receiving 0.1 million EUR from the EU. A total of **25 Chinese nationals have received an ERC grant.**

In FP7, Chinese entities participated **651** times to **413** grants of **collaborative, ERC and MC actions** of FP7, receiving **53.5** million EUR from the EU while **20.5** million EUR was the non-EU budget. Regarding **collaborative actions (excluding ERC and MSCA)**, Chinese applicants were involved 1816 times to 1145 eligible proposals, leading to **227** funded projects that involved **335** Chinese participations. Chinese participants received **33.0** million EUR from the EU while 20.5 million EUR was the non-EU budget. Regarding **MSCA** actions of FP7, Chinese entities participated **316** times to signed MSCA, receiving 20.5 million EUR from the European Commission. Also, a total of **3204** researchers of Chinese nationality participated in MSCA. Regarding **ERC grants** of FP7, a total of **8** Chinese nationals received an ERC grant.

Compared to FP7, in Horizon 2020 there has been a drop in the number of Chinese participations in the EU framework programme. This has been the result mainly of the new Horizon 2020 rules excluding China-based organisation, as well as those of other BRICS countries, from automatic funding. This trend, however, has been partially reversed since the Work Programme 2016/17 with Horizon 2020 initiatives specifically dedicated to cooperation with China.

Figure 2: Participation of China in Horizon 2020



Note: Participations of beneficiaries, third-parties and partner-organisations.
 Source: DG Research and Innovation - International Cooperation
 Data: CORDA (JRC, EIT and art.185 not included); extraction date: 15/10/2018

2.2. Current EU-China cooperation and future perspective in key priority areas

Research and innovation cooperation with China spans a wide variety of thematic areas. Through policy dialogue under the EU-China S&T Agreement several initiatives have been agreed and pursued under FP7 and Horizon 2020.

2.2.1. Food, Agriculture and Bioeconomy (FAB)

The EU and China are two of the biggest trading partners and food producers in the world, and face many similar nutrition and food security challenges. The overall challenge is to ensure sustainability of the agri-food systems catering for the needs of the growing population (especially in cities), the reduction of food and agricultural losses and waste, and the provision of safe and healthy foodstuffs.

A Flagship initiative on Food, Agriculture and Biotechnologies (FAB) was launched at the EU-China Summit in November 2013 with the signature of a Letter of Intent between the European Commission and the President of the Chinese Academy of Agricultural Sciences (CAAS). This has translated so far into 12 Horizon 2020 Work

Programme topics, dedicated to cooperation with China with a total EU budget of 94 million EUR. Common priorities and Work Programme topics have been jointly identified and co-funded by the EC with CAAS and MOST. As a result 13 joint projects have been launched involving 63 Chinese partner organisations in the field of animal production (genetics/nutrition and animal diseases), plant breeding, Integrated Pest Management (IPM), soil quality, food waste, food safety biological contamination of crops, and sustainable use of agricultural waste, co-products and by-products. Three more projects are planned to be funded under 2018-2019 currently ongoing topic calls. EU-China cooperation under the FAB initiative has become more and more balanced with joint projects mobilising large number of EU and Chinese organisations (e.g. [EU-China-Safe project](#) with 15 participants from the EU and 18 from China that will work on a shared vision and mutual recognition for food safety).

For the third phase of the FAB Flagship (Work Programme 2018-20) a more balanced EU-China cooperation is envisaged with three new joint topics in the areas of integrated approaches to food safety in the agri-food chain, high-efficient management of soil quality and land resources, and use of biogas digestate for high-quality organic fertilisers.

As to the mid-to-long term perspective, the EU-China FAB flagship initiative is to be continued and reinforced through implementation of planned call topics, monitoring of ongoing joint projects, and valorisation of research results. Regular policy update and dialogue will allow the EU and China to steer the FAB Flagship in the longer terms and promote sustainable solutions for common challenges within a food system approach.

2.2.2. Environment, Climate and Sustainable Urbanisation

Sustainable urbanisation and in particular its environmental aspects is a major socio-economic challenge for both China and Europe and has been recognised by both sides, as well as by EU Member States, as a priority area for research and innovation cooperation. The project [PIANO](#) (“Policies, Innovation, And Network for enhancing Opportunities for China-Europe water cooperation”) ended up in 2018 as a strategic cooperation partnership, which had developed a Strategic Research and Innovation Agenda (SRIA). This SRIA suggests priorities in the EU-China cooperation in water innovation and offers a possible framework for how this can be structured. It also meant to support the EU-China Water Platform (CEWP).

Cooperation with China has been pursued with a package of sustainable urbanisation action in Horizon 2020 Work Programme for 2016-17. China related topics and actions included: a coordination and support action to set up a platform of stakeholders ([URBAN-EU-China](#) project), collaborative research and innovation actions on Urban Planning and on Urban Agriculture, and actions to support large scale demonstration projects on the deployment of nature-based solutions to improve urban climate resilience and water resources management (2016) and to regenerate deprived or abandoned urban areas (2017). The [URBAN-EU-CHINA project](#) started its activities as a new platform of EU and China sustainable urbanisation stakeholder in 2017. The project is currently promoting and developing joint policy strategies, creating joint urban demonstration projects and promoting city-industry-science partnerships. The Joint Programming Initiative Urban Europe driven by EU

Member States is also contributing to promote R&I cooperation on sustainable urbanisation with China notably through multilateral calls with Chinese funding agencies such the Natural Science Foundation of China (NSFC).

For the period 2018-20 two new flagship joint topics have been agreed with MOST following a scoping workshop organised by the Dragon Star Plus project. Following a high-level joint EU-China scoping Expert Workshop on “Innovative Solutions for Sustainable Urban Development’ on 29-30 November 2016 at Ningbo, European and Chinese stakeholders from policy, research and industry discussed and identified research areas of common. As a result, experts jointly defined and recommended a list of topics under these three thematic areas on EU-China co-operation for sustainable urbanisation. Consequently, the cooperation is being pursued through flagship topics under Horizon 2020 SC5 on “Nature-based solutions for restoration and rehabilitation of urban ecosystems” (WP 2018) and “Enhanced natural treatment solutions for water security and ecological quality of water in cities” (WP 2020) with a tentative EU contribution of 10 million EUR per topic. For both topics, participation of at least three Chinese partners/per project is requested as an eligibility criterion. Proposals submitted to the Work Programme 2018 topic are currently being evaluated.

Emphasis will be on green urban mobility and sustainable electrification in large urban areas, and reduction of transport impact on urban air quality with the two topics below. The two topics are intended to promote a balanced and substantial cooperation between European and Chinese partners with co-funding from MOST.

With regard to climate, considering the aim of the Paris Conference of the Parties (COP21) for more stringent commitments to reduce global greenhouse gas emissions, both EU and China committed at the Summit and Innovation Cooperation Dialogue of June 2015 to enhance their collaboration on climate-related scientific research and technology innovation, including the development and deployment of low-carbon technologies and adaptation solutions that can contribute to international efforts to combat global warming. In the field of environment water is a priority for cooperation with China. The Commission has been supporting the China-Europe Water Platform and will continue to promote policy dialogue, joint research and business development in the water sector.

2.2.3. Aviation

The EU and China both face common challenges such as the impact on climate change by growing air transport. This calls for more environmental-friendly aviation. Future air traffic management also needs to take account of new technologies, to deliver more air space capacity while reducing emissions and protecting the environment. The rapidly evolving high-tech aviation sector is of mutual interest for Europe and China and there are already numerous examples of bilateral industrial cooperation. A better coordination of research activities in aviation between the EU and China will also contribute to broader international efforts to address global challenges.

Since FP6 there has been a long standing and fruitful cooperation on aviation with the Chinese Ministry of Industry and Information Technology (MIIT) through a series of jointly supported calls and coordination actions. The latest support action GRAIN 2 launched in 2013, allowed academia, industry and public authorities to

identify common challenges and technology areas and topics of common interest. As a result, a coordinated call was launched under Horizon 2020 Work Programme 2015, which led to the selection of four joint projects with 45 EU participants and 34 Chinese participants and a total EU budget of 7.3 million EUR in the areas of engine noise reduction, environment-friendly structures, flow control, and additive manufacturing for aerospace applications. The Chinese partner organisations in the four projects were funded by MIIT. A new coordination and support action ICARe has been launched in October 2017 under Horizon 2020 (call 2016) with the task of defining future potential areas of collaboration for implementation under Horizon Europe with China and other main global aviation partner countries. ICARe has established a specific platform for structuring the dialogue with Chinese stakeholders organised in a similar coordination and supported action called INNOVATE, funded by MIIT.

Building on a long-standing cooperation on aviation research the new Aviation Task Force set up by DG RTD and MIIT in March 2017 identified new topics to promote EU-China Cooperation for 2018-2020 in the area of aviation operations impact on climate change. In particular, balanced cooperation with China will be sought on mitigation strategies towards greener flight trajectories and mitigation strategies based on changes in the use of alternative fuels.

Future cooperation will involve the close monitoring of the on-going projects and the identification of priorities through stakeholders' consultation and structured policy dialogue with MIIT taking into account the findings of the joint projects.

2.2.4. Surface Transport

Transport is a key enabler of economic activity and social inclusion. While providing essential services to society and the economy, transport plays also an important role in economic growth and it is at the core of a number of major sustainability common challenges, in particular climate change, air quality, safety, energy security and efficiency in the use of resources

Cooperation with China on Surface Transport builds on past multilateral cooperation with CSA projects like the project SOLUTIONS (2013-2018) supporting the uptake of innovative sustainable urban mobility solutions in Europe.

Cooperation with China in 2018-20 focuses on transport impact on urban mobility, sustainable electrification, air quality, and freight transport systems, and is promoted through several Horizon 2020 topics targeting China as well as other international partner countries. This is reflected in the Horizon 2020 Work Programme 2018-2020, where China is a targeted country in three sustainable surface transport INCO Flagships: "InCo Flagship on Reduction of transport impact on air quality", "InCo Flagship on Integrated multimodal, low-emission freight transport systems and logistics ", and "InCo Flagship on Urban mobility and sustainable electrification in large urban areas in developing and emerging economies". In addition, Chinese cooperation is encouraged in the

multimodal topic “Harnessing and understanding the impacts of changes in urban mobility on policy making by city-led innovation for sustainable urban mobility

2.2.5. Energy (RD-PUNE)

Since the signature of the RD-PUNE agreement in 2008, China has become one of the principal nuclear research interlocutors for Euratom. China is a leading actor in fusion energy research, a full member party of ITER and the only country with plans to build a new fusion machine complementary to ITER in the next decade, the so-called Chinese Fusion Engineering Testing Reactor (CFETR). Cooperation with China on nuclear research has been intense so far.

On fission, Euratom continues to encourage the participation of Chinese entities in the coming Calls under the Euratom Work Programmes. Further, the Euratom Work Programme 2016-2017 included provisions for specific targeted actions on international cooperation in fission R&D between Euratom and China. Under this action, an effective dialogue on the strengthening cooperation in mid-term perspectives on nuclear safety, decommissioning and waste management via programmatic discussion is ongoing.

On fusion research, there are 111 on-going activities, involving 18 European and 21 Chinese entities. The two sides also decided to intensify cooperation under the RD-PUNE-Fusion via the Technology Management Plan (and the associated Project Plans) notably in the areas of Joint development of the Chinese Fusion Engineering Testing Reactor (CFETR) and of the European Demonstration Fusion Power Reactor (DEMO) design (Materials testing and qualification, Breeder Blanket development, Other technologies necessary for the realization Materials testing and qualification, Systems integration and assessments, Plasma Scenario development, Safety and socio economic studies and assessments) and the undertaking of joint operation of major research infrastructures in support of future ITER operation (Physics and technology of long pulse operation, Heat exhaust, plasma-wall interaction and divertor optimization, model validation, Disruption mitigation, Training activities on ITER operations, other experiments relevant to the design and definition of CFETR and EU DEMO). The EUROfusion 2018 Work Plan (implementing the European Fusion Joint Programme) includes the specific EU-CN cooperation activities. Education and training contribute to the development and implementation of the priorities identified.

In the longer term China will continue to be a strategic partner for the EU in peaceful use of research cooperation also due to Chinese boosting nuclear energy programmes.

2.2.6. Energy (non-nuclear)

China is a strategic partner for the EU in energy research and innovation (R&I) considering the size of its market, its commitment to increase RD&D spending for clean energy as well as its commitment to the Paris

Agreement. China plays a crucial role in Mission Innovation that aims to accelerate clean energy innovation through doubling of governmental investment into clean energy RD&D, encouraging public sector engagement and by sharing information on respective national clean energy innovation plans, programmes and needs. In this context, China successfully hosted the 2nd Mission Innovation ministerial meeting in 2017 and actively took part in the 3rd Mission Innovation ministerial meeting in May 2018.

Cooperation with China in the field of clean energy research has maintained a reasonable momentum, particularly in Carbon Capture and Storage (CCS). Past cooperation in FP7 focussed on Carbon Capture and Storage (CCS) through Chinese participation in projects on Near Zero Emission Coal (NZEK). Chinese organisations participated actively in the EU funded projects and contributed to innovative results also for instance on membranes for CCS. For instance, the Horizon 2020 project CHEERS (Chinese-European Emission-Reduction Solutions²) launched in October 2017 involves three Chinese partners with the aim of demonstrating large-scale decarbonisation of industry, offering a considerable potential for retrofitting industrial combustion processes. Twinning workshops on Concentrated Solar Power were also organised with the Chinese Ministry of Science and Technology. In Horizon 2020 Chinese participation has also focused on hydrogen safety for energy applications.

Mission Innovation is a key enabler to step up cooperation with China on clean energy R&I. Several topics under Horizon 2020 Work Programme 2018-20 offer cooperation opportunities for European and Chinese researchers. In particular cooperation with China will continue to be strongly encouraged in topics related to Conversion of captured CO₂ and Low carbon industrial production using carbon capture utilization and storage (CCUS). In the longer term there is potential for strengthening EU-China R&I cooperation in clean energy both through Mission Innovation and targeted bilateral activities in areas of common interest and shared benefit.

2.2.7. Biotechnologies and Biomaterials

There has been a long standing cooperation on biomaterial research with the FP7 with the National Natural Science Foundation of China (NSFC), a leading Chinese funding agency for basic research running joint calls with a number of EU Member States.

Biomaterials were a priority area for the EU and for China. Under FP7, In 2013, a joint call on biomaterials was successfully implemented with the NSFC leading to three joint EU-China projects in the areas of tissue prototyping of bio scaffolds for bone regeneration, nervous system and urethra reconstruction.

Building on positive past experiences a new flagship on biotechnologies research cooperation with the NSFC was launched in October 2017 for the period 2018-20. Three Horizon 2020 topics dedicated to cooperation with China are foreseen, two topics on new biotechnologies for environmental remediation (in 2018 and 2020) and one topic on microorganism communities for plastics bio-degradation (in 2019). Projects jointly selected in these

² <https://www.sintef.no/en/projects/cheers-chinese-european-emission-reducing-solutions/>

areas are intended to promote substantial and balanced cooperation with China with co-funding from Horizon 2020 and from the NSFC.

2.2.8. ICT

With 56 participations, China was the second most successful country in the FP7 ICT theme (after the USA). Due to new funding rules in Horizon 2020, a drop in Chinese participation in ICT related projects has been registered. However, China-owned organisations based in Europe (e.g. Huawei) have participated actively in the ICT actions under Horizon 2020. To date, 19 projects managed by DG CONNECT have Europe-based Huawei branches as partners. The EU has contributed 11.5 million EUR to various Huawei entities in these projects.

Under the existing EU-China ICT Dialogue, the Commission continues to cooperate with the Ministry of Industry and Information Technology (MIIT) on a number of policy issues under their responsibility, such as certain aspects of market access, including standardisation bodies, and reciprocity in research projects. The latest such dialogue took place in September 2018 in Beijing.

China and the EU share a common vision on how the fifth generation of mobile communications networks ("5G") could support the wider digitisation of industry, based on the Joint EU-China Declaration signed in September 2015. The declaration openly acknowledges the challenges that exist and aspires to work towards full reciprocity as well as legal and practical openness on both sides.

In November 2016, a two-year Coordination and Support Action, which includes six Chinese partners, kicked off to study how to improve EU-China bilateral collaboration on the Internet of Things and 5G.

In the current ICT work programme (2018-2020), cooperation with China on 5G is boosted by project twinning to enable close collaboration with the "5G Major Project" (funded by China). One EU project has been selected from this call (5G-Drive) and started in September 2018. The specific challenge is to demonstrate technologies and system interoperability for a number of core applications of interest for the two regions.

2.2.9. Research Infrastructures

The strategic relevance of collaboration amongst European and Chinese Research Infrastructures has been growing over the years. Chinese partners were already involved in a number of Research Infrastructures listed on the European RI Roadmap produced by the European Strategy Forum on Research Infrastructures in environmental sciences (EISCAT 3D), radio-astronomy (SKA), arctic sciences (SIOS) and Energy Carbon Dioxide Capture and Storage (ECCSEL). Chinese facilities have a dialogue with European counterparts in high-energy physics, radio-astronomy, virology and bio-diversity. The topic Integrating Activities for Advanced Communities in Horizon 2020 Work Programme 2018-20 calls for participation of international partner countries including

China. The Commission remains open to dialogue on research infrastructures in order to exchange good practices and identify possible future cooperation activities.

2.2.10. Health

Health research is an area where the EU and China have a lot to gain from closer cooperation. There has been a strong tradition of cooperation on Health in the context of FP7 and within multilateral initiatives aimed at addressing global health challenges. Mutually beneficial cooperation between EU and Chinese organisations is taking place in the areas of rare diseases (within the International Rare Diseases Research Consortium³), of chronic diseases (in the frame of the Global Alliance for Chronic Diseases⁴) and of cancer (as part of the International Cancer Genome Consortium⁵). Cooperation might be strengthened in particular on the prevention and treatment of infectious diseases, in the context of initiatives such as the Global Tuberculosis Vaccine Partnership. The area of traumatic brain injuries, where cooperation was already established during FP7 with some key projects, might be reinforced with the joint participation in the International Initiative for Traumatic Brain Injury⁶. In Horizon 2020 Work Programme for 2018-20 a coordination and support action topic was published in 2018 to promote a Strategic collaboration in health research and innovation between EU and China. Another coordination and support action in the area of personalised medicine is open to the participation of China in 2019, Other areas to be explored in the future are brain research, Alzheimer's disease, diabetes and respiratory diseases.

2.2.11. Joint Research Centre (JRC)

In line with the overall Commission strategy on international cooperation in R&I, the Joint Research Centre (JRC) acting as the European Commission's in-house science service has established an active and wide-ranging scientific cooperation with several Chinese universities and government bodies as well as in a multilateral context, to provide evidence for policy responses to common challenges including space and earth observation, disaster risk management, nuclear safety and security, food safety and security, consumer products, transport, pollution prevention and control.

The JRC signed several research arrangements with China in recent years, the latest of which with the Chinese Academy of Sciences (CAS) and the Chinese Research Academy of Environmental Sciences (CRAES). The JRC has also key role in the implementation of the RD-PUNE Agreement, the Sino-EU Panel on Land and Soil (SEPLS) and the Group on Earth Observation (GEO) and supports the EU-China-ESA trilateral dialogue.

³ www.irdirc.org

⁴ www.gacd.org

⁵ www.icgc.org

⁶ <https://intbir.nih.gov/>

Most of the current areas of scientific and research cooperation with China will continue to be a priority in the future including: space and earth observation, disaster risk management, agriculture and food security, food and feed safety and quality (and consumer protection), nuclear safety and security, transport and energy, air quality, soils and land, and water. In particular, the JRC will reinforce and extend collaboration to other areas such as climate, environmental pollution, smart grids, innovation ecosystems and territorial aspects of innovation, including smart specialisation.

In the area of land and soil, research cooperation is pursued via the EU-Sino Panel on Soil and Land. In the area of transport research and vehicle emissions cooperation continues under the scope of the new framework arrangement with CRAES. The JRC implements its strategic partnership with the CAS on the basis of the framework arrangement signed by both institutions in 2017. Finally, the JRC also intends to develop collaboration with CASTED on innovation.

2.2.12. European Research Council (ERC)

ERC awarded a total of **30** grants to principal investigators with Chinese nationality: 11 in 2015, 12 in 2016 and 7 in 2017 mostly in physical sciences and engineering. Destination countries of visiting researchers in 2015 and 2016 are the UK (six), Spain (four), Austria, Denmark, the Netherlands and France (two each) and Estonia, Sweden, Ireland, Belgium and Germany (one each). In addition, an extrapolation to some 7,000 ERC projects would indicate that there are currently altogether an estimated **1300** team members with Chinese nationality engaged in ERC projects. The ERC Implementing Arrangement with the National Natural Science Foundation (NSFC) of China was signed on 29 June 2015, on the occasion of the 2nd EU-China Innovation Cooperation Dialogue. The Arrangement provides opportunities for Chinese researchers who are active holders of NSFC competitive grants to pursue research collaboration with ERC grantees on single long-term visits (6-12 months) or multiple short-term visits. Three calls for expression of interests have been published by ERC in cooperation with NSFC so far, which led to 944 applications by Chinese scientists of which 30 were selected to collaborate with ERC teams. The ERC Scientific Council and NSFC will continue to further promote cooperation in the context of the Implementing Arrangement.

2.2.13. Space research and GEO

Space cooperation between Europe and China is growing rapidly. Both sides welcomed the ITU (International Telecommunication Union) frequency coordination that has been achieved between Galileo and BeiDou, in January 2015, after years of work and this should be concluded once details of the BeiDou operational transition are provided. Cooperation is also continuing through the China-Europe GNSS Technology Training and Cooperation Centre (CENC). Chinese organisations have been involved in Horizon 2020 space research projects such as COMPET (Space Science and Exploration) and in PROTECT (Space Weather and Near Earth Objects).

Under the EU-ESA-China Dialogue on Space Technology Cooperation the EU and China are committed to further reinforcing research and innovation cooperation. On Satellite Navigation, the EU and China would like to enhance cooperation for civil purposes between their respective global navigation satellite systems, Galileo and Beidou. Earth Observation is also a priority for R&I cooperation. In this area the two sides will continue to cooperate by improving access to data from Chinese Earth Observation satellites and derived products, continuing the operationalization of Copernicus and China's Earth Observing program (HDEOS). In the area of Space Research under Horizon 2020 the participation of Chinese organizations is welcomed and should be further be stimulated in the future especially in science and space exploration projects of a global nature, for example, space weather, NEO (Near Earth Objects), solar system exploration and Space Science.

China is one of the four co-chairs of GEO (Group on Earth Observation) together with the EU South-Africa and USA. Since 2005 GEO has been working on the implementation of a Global Earth Observation System of Systems (GEOSS). GEO has been advocating full and open access to Earth observation data worldwide, with for instance the data of the Chinese meteorological satellite Fengyun-3 being delivered freely to GEO Communities and in Europe the full and open dissemination of Copernicus data and services. China and the European Commission are supporting through the GEO engagement strategy the use of GEOSS resources in the implementation of three main international activities, the 2030 Agenda for Sustainable Development, Climate Change and Greenhouse Gas Monitoring; and Disaster Risk Reduction.

The contribution of GEO to those activities takes place in implementing a new GEOSS work programme that spans the years 2017-19. China and the EU are contributing to this Work Programme in several prominent domains such as the GEO Global Agricultural Monitoring System (GEOGLAM), the GEO Cold Region Initiative, or the Geo Biodiversity Observation Network (GEO BON). Both China and the European Union are involved in the development GEOSS regional initiatives aiming at strengthening the delivery of Earth Observation services for regional and local users (EuroGEOSS in Europe and AOGEOSS in Asia). In this context, enhanced cooperation between those regional initiatives could be envisaged in particular regarding mutual access to big observation data, and best practices for the use of those data.

2.2.14. Researchers' mobility

EU-China relations should also to be strengthened by supporting two-way mobility of researchers and academic staff. Mobility is essential to enhance researchers' skills and careers but also to initiate cooperation between institutions and to work together to jointly tackle global challenges. The agreement between the ERC and the Natural Science Foundation of China represent a valuable tool for promoting enhanced and more balanced mobility of researchers, as do the Marie Skłodowska-Curie Actions (MSCA), where 904 Chinese researchers have already participated in the MSCA under Horizon 2020.

In the longer term, a more balanced researchers' mobility flow between the EU and China is envisaged. There is the need for China to make the framework conditions for researcher mobility as attractive as possible, inter alia by ensuring equal opportunities for funding and academic positions. The increased budget for the MSCA Global

Fellowships - from 30 million to 48 million EUR per year - in the Horizon 2020 Work Programme 2018-2020 allows more European researchers to conduct their research project outside of Europe, including in China. In addition, the eligibility conditions for researchers to participate in the MSCA Research and Innovation Staff Exchanges (RISE), which is often a first step for international partners wishing to participate in Horizon 2020, have been drastically simplified through the Work Programme 2018-2020. These measures should contribute to increasing the mobility flows of researchers between the EU and China.

2.3. Current framework conditions for EU-China S&T cooperation

Having the right framework conditions in place is essential for EU-China STI Cooperation and for making EU and China attractive global research and innovation players. Framework conditions have been constantly improving in recent years. Funding for research and innovation in China is abundant and the recent reform of the Chinese STI funding system promise more transparency, quality and opening to international cooperation.

Reciprocity in the treatment of European researchers and Innovators in China is considered key for ensuring balanced and mutually beneficial EU-China R&I cooperation. There have been improvements in reciprocal access to respective R&D funding programmes, for instance the China's National Key R&D Programme (NKP) management rules are now de-facto encouraging joint research by Chinese and foreign applicants. However, there is still plenty of scope for further improvements in transparency and predictability of Chinese STI funding opportunities including the conditions for obtaining high and new technology enterprise status (HNTE). The new Made in China 2025 programme, can offer great opportunities for European researchers and innovators to contribute to innovation in China as long as China ensures equal treatment of foreign invested and domestic enterprises. The agreement on a reciprocity roadmap with MOST will continue to be implemented and be subject to close monitoring.

Several other research and innovation framework conditions still remain suboptimal. On intellectual Property Rights (IPR) China has made considerable efforts both in terms of regulatory protection and enforcement. On the enforcement front, while the legal instruments are available, there is room for reducing discrepancies between provinces, and increase predictability, uniformity and quality of court decisions. The rules about technology transfer are perceived as discouraging European companies from putting further investment in R&D in China. EU-China cooperation could also benefit of more flexibility in the visa policy for scientific staff, to facilitate international mobility for scientists exchange at all levels, including experts as well as young talents.

Finally on standardisation, most of the Chinese standardisation bodies include a very limited participation of European businesses, although these organisations play an important part in R&D and innovation in China. Promoting the participation of Foreign Invested Enterprises (FIEs) in the Standards Definition Process could contribute to enhancing the competitiveness of China-developed technologies in the international market.

3. PRIORITIES FOR THE FUTURE IN S&T COOPERATION

3.1. Areas of future S&T cooperation agreed at latest Joint Committee/High Level Dialogues

In the framework of the EU-China High Level Innovation Cooperation Dialogue and Joint Steering Committee on Science and Technology cooperation both sides reiterated the willingness to continue to reinforce the already strong links between their respective scientific communities and innovation actors. The EU and China recognised that they have a shared responsibility in addressing global societal challenges and the Agenda 2030 Sustainable Development Goals through Science, Technology and Innovation (STI) cooperation, and that innovation is at the core of both EU and China strategies for sustainable development and prosperity.

A new package of EU-China flagship initiatives was agreed for the period 2018-2020 targeting the areas of Food, Agriculture and Biotechnologies, Environment and Sustainable Urbanisation, Surface Transport, Safer and Greener aviation, and Biotechnologies for Environment. Cooperation on energy R&I is pursued in the framework of Mission Innovation.

The flagship initiatives and priority areas translate into a number of topics dedicated to cooperation with China under Horizon 2020 co-funded from China either via the general co-funding mechanism by MOST or by other Chinese funding agencies. The emphasis will be on green initiatives with actions on ecological quality of water in cities, nature-based solutions for restoration and rehabilitation of urban ecosystem, reduction of transport impact on air quality, aviation operations impact on climate change or biotechnologies for environmental remediation.

Both sides confirmed their commitment to improve innovation framework conditions, promote open science, strengthen links between respective innovation platforms, strengthen cooperation in developing technical standards and intellectual property policies, facilitate researchers' mobility, and encourage researchers' two-way entrepreneurship across borders.

In summary, while STI cooperation with China is bound to be continued and increased across the board, the following areas will continue to be pursued in the future with a specific efforts through dedicated thematic dialogue and joint or coordinated actions:

Flagship initiatives:

- Food, Agriculture and Bioeconomy (FAB)
- Environment, Climate & Sustainable Urbanisation
- Aviation
- Biotechnologies and biomaterials
- Surface Transport

Other key priority areas of cooperation:

- Peaceful use of nuclear Energy (RD-PUNE)

- Energy (non-nuclear)
- ICT
- Space research and GEO
- Research Infrastructures
- Health

3.2. Improvements in framework conditions agreed at latest Joint Committee/High Level Dialogue

- Co-Funding Mechanism (CFM)

At the 2015 Summit and ICD, the EU and China reached a breakthrough agreement on the setting up of a Co-Funding Mechanism (CFM) for research and innovation cooperation. The guidelines for the CFM were agreed at the Joint Steering Committee meeting of October 2015 and the Chinese Ministry of Science and Technology published calls for proposals with several deadlines in 2016, 2017 and 2018 (the last one on 22 October 2018).

At ICD-3 June 2016 the CFM was renewed for the period 2018-2020, during which MOST intends to allocate 200 million RMB, or about 26 million EUR on an annual basis to provide competitive funding to China-based entities participating in joint projects with European partners under Horizon 2020. The European Commission has reserved a budget of up to 100 Million EUR in Horizon 2020 calls targeting cooperation with China during the same period.

- Reciprocity in access to respective STI funding programmes

Progress was also made on the issue of reciprocal access to respective STI funding programmes. At ICD-3 the two sides reconfirmed on the principle of reciprocity in improving access to STI programmes and resources, and agreed to address jointly the recommendations that emerged from the monitoring of reciprocity roadmap.

- The two sides also agreed to promote open science and to exchange best practices in open access to publications and research data, with open access as the default option for research they fund.

ANNEX:**HORIZON 2020 WORK PROGRAMME 2018-20 TOPICS EXPLICITLY ENCOURAGING COOPERATION WITH CHINA**

	Topic identifier	Topic title
2018	CE-BIOTEC-04-2018	New biotechnologies for environmental remediation (RIA)
	CE-SC3-NZE-2-2018	Conversion of captured CO ₂
	ICT-22-2018	EU-China 5G Collaboration
	INFRAIA-01-2018-2019	Integrating Activities for Advanced Communities
	LC-MG-1-1-2018	InCo flagship on reduction of transport impact on air quality
	LC-MG-1-3-2018	Harnessing and understanding the impacts of changes in urban mobility on policy making by city-led innovation for sustainable urban mobility
	NMBP-13-2018	Risk Governance of nanotechnology (RIA)
	NMBP-14-2018	Nanoinformatics: from materials models to predictive toxicology and ecotoxicology (RIA)
	SC1-HCC-03-2018	Support to further development of international cooperation in digital transformation of health and care
	SC1-HCO-01-2018-2019-2020	Actions in support of the International Consortium for Personalised Medicine
	SC1-HCO-11-2018	Strategic collaboration in health research and innovation between EU and China
	SC5-13-2018-2019	Strengthening international cooperation on sustainable urbanisation: nature-based solutions for restoration and rehabilitation of urban ecosystems
	SFS-38-2018	Highly efficient management of soil quality and land resources
2019	CE-BIOTEC-05-2019	Microorganism communities for plastics bio-degradation (RIA)
	CE-SFS-39-2019	High-quality organic fertilisers from biogas digestate

	LC-CLA-07-2019	The changing cryosphere: uncertainties, risks and opportunities
	LC-GV-05-2019	InCo flagship on “Urban mobility and sustainable electrification in large urban areas in developing and emerging economies”
	LC-MG-1-6-2019	Aviation operations impact on climate change
	LC-SC3-NZE-5-2019-2020	Low carbon industrial production using CCUS
	MG-2-9-2019	Integrated multimodal, low-emission freight transport systems and logistics (Inco Flagship)
	NMBP-15-2019	Safe by design, from science to regulation: metrics and main sectors (RIA)
	SFS-37-2019	Integrated approaches to food safety controls across the agri-food chain
	SU-SPACE-22-SEC-2019	Space Weather
2020⁷	NMBP-xx-2020	New biotechnologies for environmental remediation (under consideration, to be confirmed)
	SC5-25-2020	Strengthening EU-China cooperation on sustainable urbanisation: Enhanced natural treatment solutions for water security and ecological quality of water in cities
	SFS-40-2020	Healthy soils for healthy food production

⁷ The 2020 topics are subject to the formal adoption of the Work Programme after consultation of EU Member States.

Figure 3: China – Top scientific areas compared to EU28 in terms of citation impact of publications

	Scientific Area	Share in world output	Share of international co-publications	Citation Impact	
				Difference with EU28	8-year trend
High publication output	Materials Science: Biomaterials	17,4%	28%	+0.56	↑
	Chemical Engineering: Catalysis	23,1%	23%	+0.51	↑
	Biochemistry, Genetics and Molecular Biology: Biophysics	15,2%	22%	+0.36	↑
	Chemistry: Electrochemistry	26,1%	18%	+0.26	↑
	Materials Science: Surfaces, Coatings and Films	22,2%	19%	+0.15	↑
	Chemical Engineering: Bioengineering	18,5%	25%	+0.1	↑
	Materials Science: Ceramics and Composites	25,8%	18%	+0.07	↑
	Environmental Science: Pollution	17,1%	22%	+0.06	↑
	Chemistry: Organic Chemistry	19,8%	16%	+0.04	–
	Environmental Science: Waste Management and Disposal	19,4%	22%	+0.04	–
Low publication output	Arts and Humanities: Archeology (arts and humanities)	1,4%	62%	+3.44	–
	Pharmacology, Toxicology and Pharmaceuticals: Miscellaneous	2,2%	50%	+3.29	–
	Social Sciences: Archeology	1,5%	61%	+1.79	–
	Social Sciences: Miscellaneous	1,3%	58%	+0.73	↑
	Social Sciences: Anthropology	1,0%	51%	+0.7	↑
	Arts and Humanities: Music	0,8%	48%	+0.62	–
	Arts and Humanities: History	0,6%	34%	+0.57	↑
	Arts and Humanities: History and Philosophy of Science	0,8%	72%	+0.55	–
	Veterinary: Small Animals	1,8%	17%	+0.5	–
	Chemical Engineering: Colloid and Surface Chemistry	18,2%	29%	+0.45	↑

Source: DG Research and Innovation – International Cooperation

Data: Elsevier SciVal; extraction date: 6/8/2017; publications' window: 2011-2013; citations' window: 3 years

Note: These tables show scientific areas in which the country's academic publications have a higher citation impact than EU28, and whether this difference has decreased, increased or remained the same in the past 8 years. They are grouped in two tables. The top table focuses on areas with high share of publications in the country's total output of publications and the bottom table on those with low share of publications. Scientific areas are based on Elsevier 'All Science Journal Classification'. For each area, the country's share in the world output of publications and the share of international co-publications are also shown.

Figure 4: China – Specialisation compared to EU28 in selected technologies based on PCT patents

	Technology	2014 PCT patents	2014 PCT patents of EU28	2014 Specialisation compared to EU28	8-year trend
OECD classification	ICT	15.818	14.579	2,17	↑
	Pharmaceuticals	852	2.524	0,67	↓
	Nanotechnology	37	137	0,55	↑
	Selected environment-related technologies	908	3.663	0,49	↓
	Biotechnology	602	2.745	0,44	↓
	Medical technology	794	3.879	0,41	–
WIPO classification	Digital communication	5.426	2.700	3,66	↓
	Audio-visual technology	1.488	761	3,56	↑
	Computer technology	3.190	1.762	3,29	↑
	Telecommunications	1.193	749	2,90	↓
	Optics	1.320	959	2,50	↑
	Semiconductors	938	820	2,08	↑
	IT methods for management	331	425	1,42	↑
	Other consumer goods	740	1.238	1,09	↑
	Control	431	784	1,00	↑
	Electrical machinery, apparatus, energy	1.629	3.101	0,96	↓
	Basic communication processes	140	268	0,95	↑
	Furniture, games	453	952	0,87	↓
	Thermal processes and apparatus	356	791	0,82	↓

Source: DG Research and Innovation – International Cooperation

Data: OECD (top table) WIPO (bottom table); extraction date: 6/8/2017

Note: The top table shows the relative specialisation of the 2014 PCT patent output of the country with respect to EU28, calculated as (# of patents of country in technology X / # of patents of country in all technologies) / (# of patents of EU28 in technology X / # of patents of EU28 in all technologies). It also shows whether the relative specialisation has increased, decreased or remained the same in the past 8 years. The selected technologies are classified based on the OECD database. The bottom table shows the same information for the top-13 technologies with the highest specialisation index with respect to EU28 - this time the technology classification is based on the WIPO database. Both tables also show the country's and EU28 total number of PCT patents under each technology in 2014.