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Policy brief

Research and Innovation cooperation between the European Union and China

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This report was composed by Cheng Fan (project leader), Stephanie Christmann-Budian and Sarah Seus. Susanne Buehrer guided the work shop and Sonia Conchi assisted the bibliometric data collection. Fraunhofer Institute for Systems and Innovation Research ISI was the contractor.

Title of the contract: Research and innovation cooperation between the European Union and China

Contract number: RTD/C2/ERIAB/2013/No.7

Client service: European Commission, DG Research & Innovation, A6 – Science policy, foresight and data

Please cite this study as: Fan, Christmann-Budian et al. (2014): Evaluation and Innovation Cooperation between the EU and China. Study for the European Commission DG RTD by Fraunhofer ISI.

Project Number: 2013.9273

Title: Evaluation and Innovation Cooperation between the EU and China

Linguistic version: EN

Catalogue number: KI-04-13-071-EN-N

ISBN: 978-92-79-33169-5

DOI: 10.2777/4860

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Executive summary

This policy brief aims to deliver input to formulate options for international policy on research and innovation cooperation under the Horizon 2020 (H2020). The focus is on EU-China cooperation due to China's increasing importance in international R&I areas. The results and recommendations should underpin the discussion of RTD's major advisory bodies (ERIAB, EFFLA and i4G)¹, which report directly to the Director General and the Research and Innovation Commissioner.

The following questions are answered in this policy brief:

- What are the strengths and weaknesses of China's STI system?
- What do China's scientific strengths and weaknesses mean for H2020/Grand Challenges?
- Which H2020 fields are promising/have cooperation potential and which are conflicting?
- Why are the EU and China interested in research cooperation?
- What are the factors hindering closer cooperation?
- How could the EU and China intensify their cooperation?

Both qualitative and quantitative analyses were applied to answer these questions. As the first step, the strengths and the weaknesses of China's scientific research areas were investigated using a quantitative analysis, i.e. a bibliometric analysis based on Scopus.² Corresponding to the time period of the Chinese "National Guideline on Medium- and Long-Term Programme for Science and Technology Development (2006-2020)" (MLP 2006-2020), Chinese publication patterns were analysed from 2006 to 2012. This made it possible to examine the correlation between the publication performance and the goals of Chinese MLP 2006-2020. Secondly, the characteristics of the STI policy mix in China were investigated by studying the relevant policy and strategy papers in order to determine the strengths and weaknesses of this system and the future challenges and tasks for the Chinese government.

Qualitative methods were used to address the final four questions such as conducting telephone interviews with prominent institutions in the EU and in China³ to identify the motivations of the cooperation, promising and conflicting areas and factors hindering cooperation activities. The interview questions were based on guidelines developed for the scope of this project (See Annex 1).

Finally, a workshop, which took place on 4th April, served to discuss, validate and further develop the conclusions drafted by the study team in the concept policy brief.⁴

¹ *European Research and Innovation Area Board (ERIAB), European Forum on Forward Looking Activities (EFFLA), Innovation for Growth (i4g)*

² *This database covers about 19,500 peer-reviewed journals. Each year, about 1.3 million new records are added to the database that not only provide the absolute number of publications in specific scientific fields, but also the citation frequencies of these publications, which allows an assessment of the alignment and thereby the quality of individual publications. In this study, the focus was on journal articles.*

³ *19 interviews were conducted. The interviewees are important stakeholders in R&I areas such as policymakers, members of higher education commissions, members of the strategic forum for international STI cooperation, members of national STI-related foundations, project managers in international cooperations, agents of international cooperations and industrial stakeholders.*

⁴ *See minutes of the workshop.*

This study reveals a high potential for cooperation between the EU and China under H2020. Promising areas were identified in "Excellent Science" (ES) and "Societal Challenge" (SC), especially in ES. Almost all the experts agree that cooperation in ES is the most promising and easiest due to the nature of scientific research. China is keen to cooperate with the EU in its, so far, comparatively "weak" fields such as "Energy", "Environment", "Health and Ageing", and "Urbanization" in order to gain access to the EU's expertise in these SC areas. In contrast, it is not easy to identify suitable cooperation models in "industrial leadership". IL refers to technology/innovation cooperation and focuses on enhancing industrial competitiveness. Nevertheless, in principle, cooperation is needed by both sides in order to benefit from each other and monitor each other regarding industrial expertise.

For this reason, the key issue is how to cooperate with each other. Various hindering factors could be found: e.g. cultural (lack of language skills, different values/research ethics, different research priorities, lack of knowledge of the capacities & potentials of the partner), strategic (lack of a common strategy of the EU towards China, lack of strategic coordination among the EU MS), and administrative (lack of effective and efficient administration for the implementation of cooperation on both sides). The recommendations from the experts and stakeholders could be categorised in six perspectives: "Principles", "Who talks to whom?", "How to set up strategic priorities?", "Improvement of efficiency and coordination of administration", "Creative cooperation forms/instruments" and "Funding issues". In addition, some recommendations refer directly to specific "ES", "IL" and "SC" areas.

In general, China is aware of its strengths and weaknesses, cooperation goals and strategy as well as the strengths and competences of the EU, but still has difficulties in approaching its EU counterparts due to a different understanding of cooperation. In contrast, there is a wide diversity of opinions among the EU MS regarding cooperation with China and the lack of a concrete, joint strategy at EU level. In fact, numerous bilateral and multilateral activities have been taking place at the level of individual MS in line with their own strengths and weaknesses, but these are not yet being coordinated at EU level.

If the EU wants to speak with one voice to China, the first step is to develop a common strategy. In order to do so, the EU has to bring together and harmonize the MS' different interests, priorities and approaches. The experts seemed to have two different approaches in this regard. The first one is to apply the already existing framework of the EU, but to strengthen the coordination between the relevant agencies and the EU MS. The second one is to create a new "EU-China research council" to ensure direct, efficient and effective decisions and R&I governance.

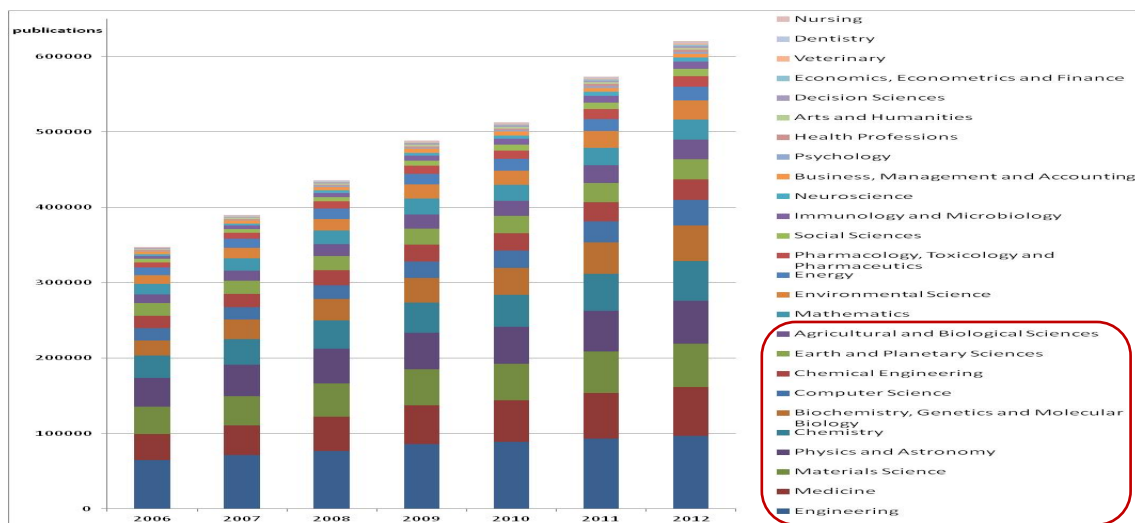
This institutional consideration might be the foundation for further and closer cooperation between the EU and China since learning effects could be transferred to other fields.

1. What are the strengths and weaknesses of China's STI system?

1.1 Strength of natural science oriented disciplines with steady quality improvement

According to the quantitative investigation of Chinese publications in terms of their absolute number, a continuous and stable increase in publications in general between 2006 and 2012 was observed (see figure 1)⁵. The most important fields listed in Scopus were "Engineering", "Medicine", "Materials Science", "Physics and Astronomy", "Chemistry", "Biochemistry, Genetics and Molecular Biology", "Computer Science", "Chemical Engineering", "Earth and Planetary Sciences", and "Agricultural and Biological Sciences". All of these are natural science oriented disciplines. These top 10 research areas remained almost constant between 2006 and 2012. However, two important changes in the ranking of these top 10 areas could be identified: firstly, 'Medicine' rose from 4th position in 2006 to 2nd position in 2011 and 2012 and secondly, "Agricultural and Biological Sciences" have been part of the top 10 since 2010.

Figure 1: Most important research areas in China's scientific research



Source: Study by the Fraunhofer ISI for this project.⁶

Despite a general growth of scientific publications, China had a very different share of publications in the top 10 research areas than compared to publications world-wide⁷. In 2012, for example, the main publication areas in China were "Engineering", "Physics", "Chemistry", and "Materials Science". On the contrary, the world showed higher shares in "Medicine", "Biochemistry", "Agricultural and Biological Sciences" (see figure 2).⁸

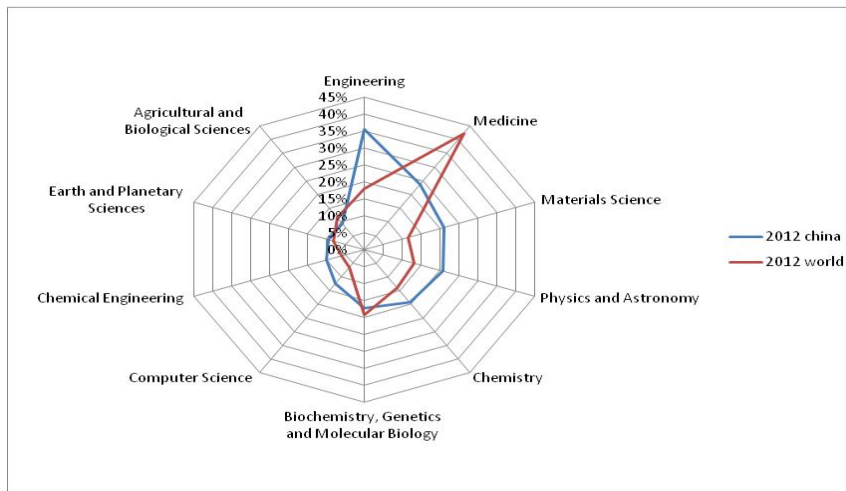
⁵ All scientific areas grew by more than 100% between 2006 and 2012 (see figure 8).

⁶ All of the following figures were based on the results of a study by the Fraunhofer ISI conducted especially for this project.

⁷ "world" means „total publications worldwide“.

⁸ In fact, the shapes of the share distribution of both China and the world have hardly changed during this period of time. However, the trend of the decreasing share of "Engineering" and "Physics" and increasing share of "Biochemistry", "Computer Sciences" and "Medicine" could be seen.

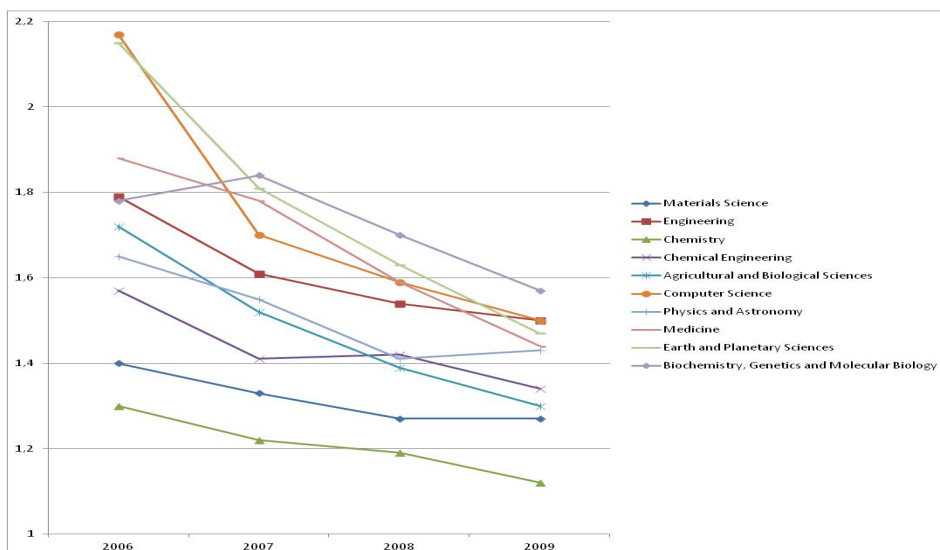
Figure 2: Share of publications in the top 10 scientific research areas: China compared to the world (2012)*



Source: Fraunhofer ISI. *Multiple counts possible.

With regard to the quality of these top 10 research areas, the ratio of the world citation rate to China's citation rate was examined.⁹ Figure 3 illustrates that firstly, the quality of almost all of these top 10 areas has been improving steadily. Secondly, the quality in general still lags behind the world average because none of the ten lines reached the threshold ratio of "one". However, "Chemistry", "Materials Science" and "Agricultural and Biological Sciences" have achieved significant progress and are relatively close to the world average. At the same time, the quality of "Computer Science", "Earth Science" and "Medicine" has been improved faster than other areas due to the steeper slopes of their quality lines.

Figure 3: Quality investigation of the top 10 research areas*



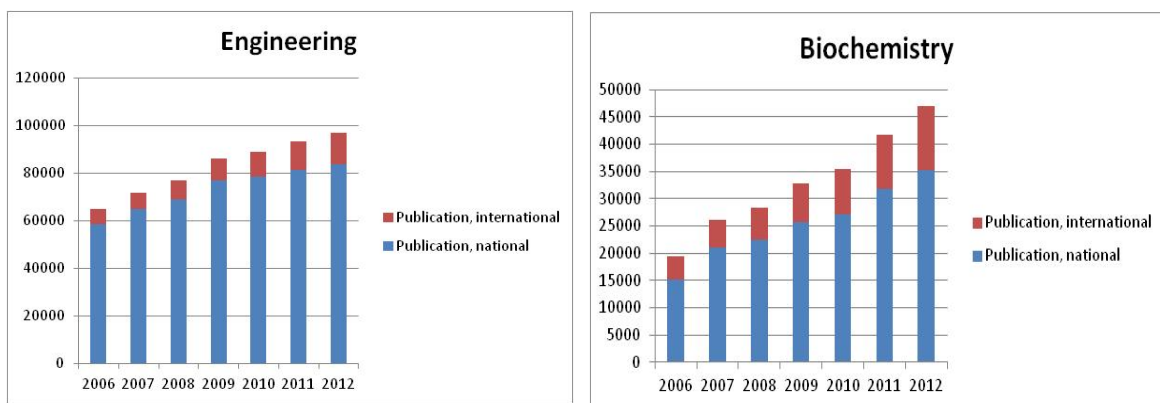
Source: Fraunhofer ISI. *(ratio = world citation rate/China's citation rate)

⁹ Citation rate refers to citation frequencies per paper. If the ratio is higher than one, that means the world citation rate is higher than China's. It implies further that China's publication level is lower than the world average level. By contrast, if the ratio is lower than one, it implies that China's publication level is higher than the world average.

1.2 Various increasing international cooperation with clear USA dominance

International co-publications between Chinese scientists and researchers from other countries have been increasing. However, the majority of publications is still national. Taking "Engineering" and "Biochemistry" as examples, a strong divergence of international cooperation could be observed: the co-publications in "Engineering" have more or less stagnated while the co-publications in "Biochemistry" have grown rapidly (see figure 4). In fact, beside "Biochemistry", the international cooperation has been increasing also in "Earth", "Agricultural and Biological Sciences" and "Medicine" areas.

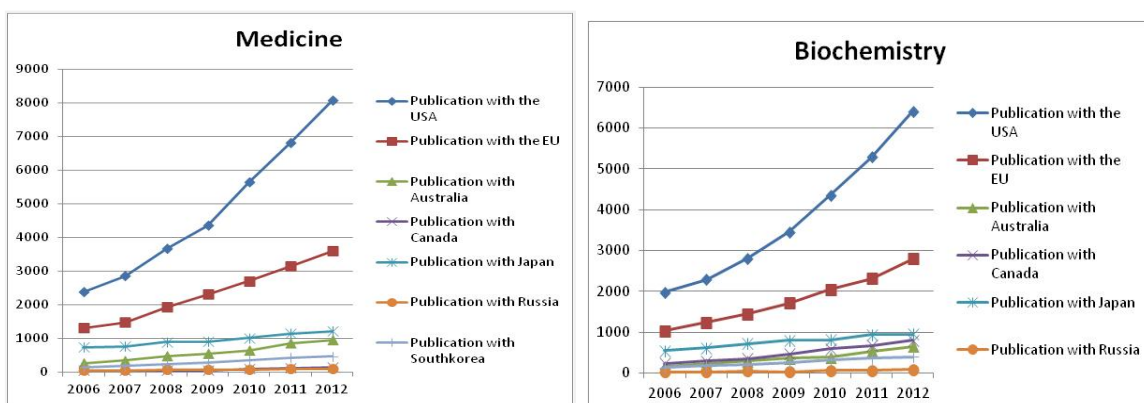
Figure 4: International cooperation – case "Engineering" and "Biochemistry"



Source: Fraunhofer ISI.

The main cooperation partners are the USA, the EU, Japan, Australia and Canada. The USA is in top position, especially in research areas such as "Medicine", "Biochemistry", "Agricultural and Biological sciences" and "Chemistry"(see figure 5).

Figure 5: Dominance of the USA in international cooperations



Source: Fraunhofer ISI.

Among the EU Member States, the UK, Germany and France are the main partners. The UK plays the leading role in almost all research areas. Germany is more important than the UK only in "Physics". In "Materials Science", "Chemistry", "Biochemistry", "Earth science", "Agricultural science and Medicine", the UK and Germany are in a similar position.

1.3 New scientific niches in China

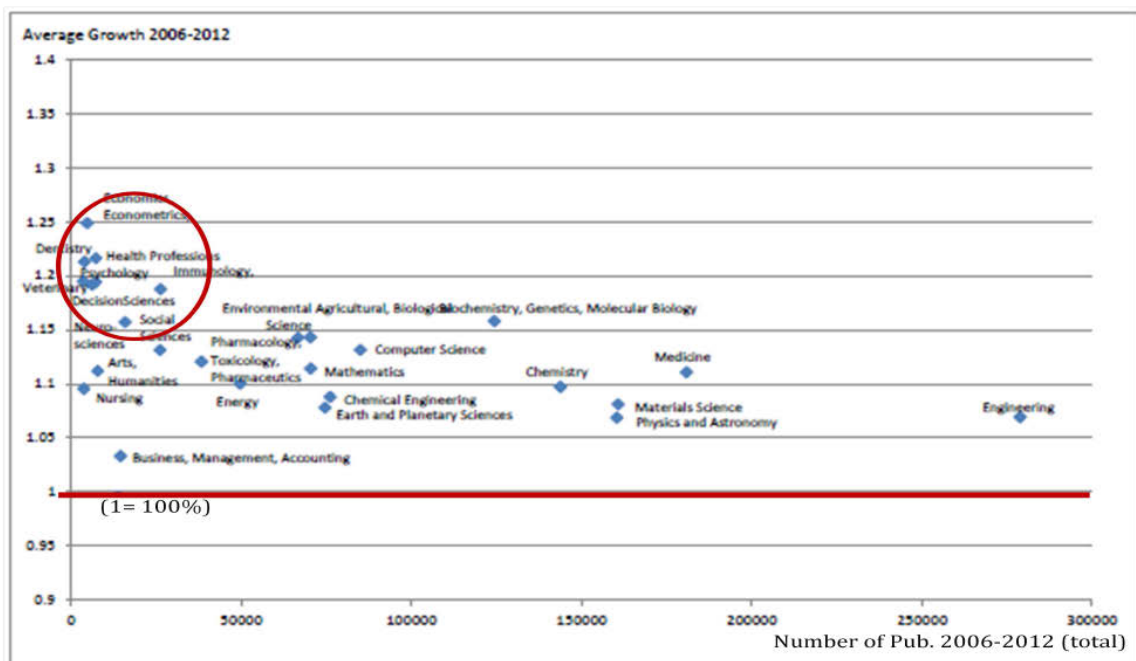
When investigating the quality of all research areas in China in terms of ratio of the world citation rate to China's citation rate, an overall improvement of the publication quality could be seen. Figure 6 illustrates that "Arts and Humanities" (not only China-specific topics, but also languages and international history), veterinary, health professions, dentistry, nursing qualitatively outperformed the world average. Combining the list with the growth rate analyses (figure 7), "Economics/ Econometrics/ Finance", "Health Professions", "Social Sciences", "Dentistry", "Veterinary", "Psychology", "Decision Sciences", "Immunology/ Microbiology" could be identified as new niches arising in China because these areas have relative higher growth rates than other areas and at the same time, the quality of most is higher than the world average.

Figure 6: Research areas where China qualitatively overperformed the world average

2006	2007	2008	2009
<ul style="list-style-type: none"> Economics, Econometrics and Finance Psychology Health Professions 	<ul style="list-style-type: none"> Economics, Econometrics and Finance Arts and Humanities Veterinary Psychology Decision Sciences Health Professions 	<ul style="list-style-type: none"> Psychology Health Professions Veterinary Economics, Econometrics and Finance Arts and Humanities Decision Sciences Dentistry Nursing Social Sciences 	<ul style="list-style-type: none"> Arts and Humanities Veterinary Economics, Econometrics and Finance Health Professions Psychology Decision Sciences Nursing Dentistry

Source: Fraunhofer ISI.

Figure 7: New scientific niches and high productivity



Source: Fraunhofer ISI.

1.4 Important findings from the bibliometric analyses

When summarizing all of the above-mentioned analyses (see figure 8), the following findings could be established:

- "Materials Science", "Chemistry" and "Agricultural and Biological Sciences" are strong research areas with a good performance. The first two are also main publication areas in China with less intensive international cooperation.
- "Medicine", "Biochemistry", "Earth" and "Computer Science" have made major progress since 2006. The first two areas have relatively stronger international cooperation, esp. with the USA.
- China has developed "Materials science", "Chemistry" and "Computer Science" very successfully based on its own efforts.
- China has tried to catch up in areas such as "Medicine", "Biochemistry" and "Agricultural and Biological Sciences" by cooperating with other countries, mainly the USA, and has been very successful.
- "Earth and Planetary Sciences" is a research field where international cooperation is not dominated by the USA and China is similar to the rest of the world in terms of its share of publications. It could imply that it is an area with high potential to cooperate with the EU.

Figure 8: Summary of the bibliometric analyses*

Top 10 research areas	Strongly improved quality	Relatively stronger /increasing international cooperation	Especially intensive cooperation with the USA	Publication share in China higher than that in the world	Publication share in the world higher than that in China	High growth rate of publications (more than 100% per year)
Engineering				X		X
Medicine	X	X	X		X	X
Materials science	X close to the world average			X		X
Physics				X		X
Chemistry	X		X	X		X
Biochemistry	X	X	X		X	X
Computer science	X			X		X
Chemistry engineering				X		X
Earth and planetary sciences	X	X		similar	similar	X
Agricultural and biological sciences	X	X	X		X	X

Source: Fraunhofer ISI. *(Green: strong areas; blue: areas with large potential)

1.5 Proactive political support in S&T development

Figure 9 provides an overview of the ambitious and proactive political support, including important long-time and continuous policy plans, supportive programs and funding schemes in China. Detailed descriptions of the goals, supported priority areas and involved authorities of respective policy documents are presented in Annex 2.

Figure 9: Overview of policy documents in China

Policy plans + Funding schemes	Time frame
National Guideline on Medium- and Long-Term Program for Science and Technology Development; 国家中长期科学和技术发展规划纲要	2006-2020 (11th-13th FYP)
12th Five-Year Plan (12 FYP) for the development of science and technology; 国家“十二五”科学和技术发展规划	2011-2015
12th Five-Year Plan for the Strategic Emerging Industries; “十二五”国家战略性新兴产业发展规划	since 2009; current 12FYP policies
12th Five-Year Plan for the development of new materials industry; 新材料产业“十二五”发展规划	2011-2015
12th Five-Year Plan for the development of energy conservation and environment; 国务院关于印发“十二五”节能环保产业发展规划的通知	2011-2015
12th Five-Year Plan for the development of Software and IT services industry; 软件和信息技术服务业“十二五”发展规划	2011-2015
Bio-industry development plan; 生物产业发展规划	2011-2015
'Key Technologies R&D Program' (国家科技攻关计划; since 2006: 国家科技支撑计划)	since 2006; current 12FYP policies
863 Program / 高技术研究发展计划 - 863 计划	since 1986; some modifications (incl. programme title) in 2006; current 12FYP policies
National Engineering Research Centres ¹⁰ / NERC / 国家工程技术研究中心	since 1988; current 12FYP policies
'National Key Basic Research Program' or 973-Program; 国家重点基础研究发展计划 / 973 计划	since 1997
Innofund Program / 科技型中小企业技术创新基金	since 1999
12th Five-Year Plan for the Development of the National Natural Science Fund (2011-2015)	2011-2015

Source: Fraunhofer ISI.

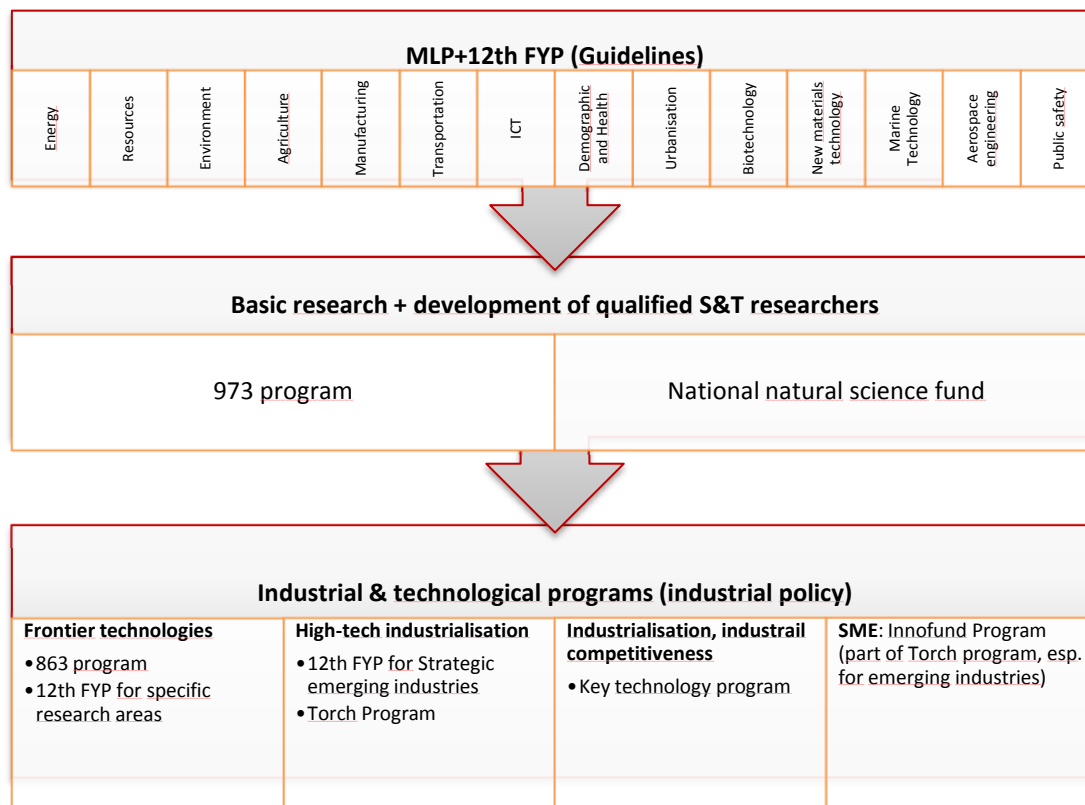
In MLP (2006-2020) 19 priority areas were selected by the State Council.¹⁰ The MLP (2006-2020) could be viewed as the core and the foundation of all other relevant policy plans and funding schemes, e.g. all other policy documents were developed, deployed and launched on the base of MLP, leading to continuity in political measures in China. In the context of the 12th FYP (Five-Year-Plan), which closely corresponds to MLP, a series of detailed plans were introduced to promote the selected 19 priority areas.¹¹ From the relationship between policy plans and political stakeholders a "top-down" approach is very obvious. This top-down approach contains a finely planned overall development for 19 priority areas: from basic research, to frontier technology

¹⁰ They are "Energy", "Water and Mineral resources", "Environment", "Agriculture", "Manufacturing", "Transportation", "Information industry and modern service industry", "Demographic and health", "Urbanization and urban development", "Public safety", "National defence", "Biotechnology", "Information technology", "New materials technology", "Advanced Manufacturing Technology", "Advanced energy technologies", "Marine Technology", "Laser Technology", "Aerospace Engineering".

¹¹ For example, 12th Five-Year Plan for the development of new materials industry; 新材料产业“十二五”发展规划, 12th Five-Year Plan for the development of energy conservation and environment; 国务院关于印发“十二五”节能环保产业发展规划的通知, 12th Five-Year Plan for the development of Software and IT services industry; 软件和信息技术服务业“十二五”发展规划, Bio-industry development plan; 生物产业发展规划.

development, to industrialisation of emerging technologies and finally to commercialisation (see figure 10).¹²

Figure 10: Top-down approach in China's S&T development



Source: Fraunhofer ISI.

1.6 Medium degree of correlation between S&T political goals and their scientific performances

The supportive inputs from the political side have achieved the political goals to a medium degree. Figure 12 illustrates the matching between S&T political goals and their scientific performances in order to find out the correlation between the political inputs and the scientific outputs. Despite a series of specific political measures for the promotion of "Energy", "Advanced Energy Technology", "Environment", "Water and Mineral resources", performance in these areas has still been comparatively weak so far (measured in terms of their publication output). Other priority areas have been performing well or have the potential to develop successfully. Therefore the Chinese government has achieved its goals in around half of the priority areas by strong political support. On the contrary, China needs to accelerate the development of "weak" areas such as "Energy", "Environment", "Urbanisation", "Health and Ageing" issues.

¹² The MLP's overall role in current Chinese STI strategies is unique because it still constitutes the dominant basis for all detailed periodical, sectoral and institutional sub plans, programmes, funding schemes, priority setting etc. So even if subfields are newly defined on the micro level and strategies of the STI sector will be more narrowly designed, this can only happen within the limits of the MLP. That means the overall framework set by the MLP, with its broader definition of policy orientation, research and technology priorities as well as the generously-funded, long-term major projects defined there, should remain binding until the end of this decade.

Figure 11: Matching between China's STI policy, priority areas and performance

National Guidelines on Medium and Long-Term Programme for S&T development (2006-2020)	973 programme during 12th FYP	863 Programme during 12th FYP	12th FYP for the strategic Emerging industries	12th FYP for specific research priority areas	Key technologies R&D programme during 12th FYP	outcomes of the bibliometric analyses
Energy	X	X	X	X	X	
Water and Mineral resources, Environment,	X	X	X	X	X	
Agriculture, Manufacturing,	X	X			X	
Transportation,		X	X		X	
Information industry and modern service industry,	X			X	X	
Demographic and health, Urbanization and urban development,	X			X	X	
Public safety, National defense.					X	
Biotechnology,		X	X	X		
Information technology,	X	X	X			
New materials technology,	X	X	X	X		
Advanced Manufacturing Technology,		X	X			
Advanced energy technologies,		X				
Marine Technology,		X				
Laser Technology						
Aerospace Engineering		X				

Source: Fraunhofer ISI. (Green: strong areas; blue: areas with large potential)

1.7 STI System with "Chinese characters"

In order to gain a deeper insight into the reasons why areas such as "Energy" and "Environment" are still relatively weak, the specific characters of the Chinese STI system are examined. Furthermore, a better understanding of the STI system in China can help to make more accurate predictions about its future STI performance and find out the interests of the Chinese side for closer cooperation.

Hybridity as system characteristics: After the political and economic opening up at the end of the 1970s under Deng Xiaoping, China reformed its STI system stepwise. The National S&T Conference in 1978 – which is historically regarded as the first important event in this context – led to the rehabilitation of science and technology and its stakeholders in the political structure of the PRC.¹³ So at that time the Chinese STI system faced the challenge to rapidly and effectively transform a centralized Soviet style planning system into a market-oriented macro-managed and competitive system which serves the national economic goals. Gradually, new institutions were added to or replaced parts of the old structure which itself also took some time to recover from the destruction of the Cultural Revolution (1966-1976).¹⁴

New and old patterns combined with State/SOE dominance: Since the mid-1980s, the Chinese government has decided to develop the Chinese S&T system

¹³ This new position as a national priority field also manifested itself in the place that S&T and education took as one of the four main pillars of the new "Four Modernisations Strategy" for national development (Suttmeier, 1980).

¹⁴ Another impact of that decade of political turmoil is the lack of one whole generation of highly-qualified employees which until now can be perceived as an imbalance in the national S&T capacities, esp. with regard to experienced scientists.

through implementing several internationally (esp. Western) inspired institutions and funding programmes as well as capacity building initiatives (overseas scholarships, massive extension of university intake). For instance, the National Natural Science Foundation of China (NSFC, founded in 1986) was strongly influenced by the US-American National Science Fund and the German Research Foundation. The Torch and Spark Programme as another example for state funding initiatives aimed at modernizing Chinese (urban as well as rural) regions by implementing High-Tech-Parks and providing means for technological upgrade.¹⁵

Nevertheless, the dominating role of the Chinese government still remains e.g. via the often monopolistic state-owned enterprises (SOE). Analyses of the Chinese private sector and its activities in the field of STI must consider that the majority of the national enterprises are still completely or partially state-owned and controlled. This might be a reason, why the overall performance of the private sector in terms of STI still lags behind expectations. The corporate sector therefore still receives incentives to become more directly engaged in (in-house) research or – as a growing trend – to become active abroad for on the spot R&D and Know How/Technology Transfer. Another example of remaining structures are the efforts to reduce the redundant and inefficient R&D institutions in the S&T sector (especially those of the sectoral administrative departments), a process that has been ongoing for three decades already (IDRC, 1997).

Institutional isolations and redundancy: However, several of the former structures inside the Chinese STI system as well as in the general political framework have remained so that the newly implemented stakeholders still develop own characteristics (so-called Chinese style) and interactions (or rather the lack of interaction as another traditional pattern remains). The same applies to the main aspects of the decision making "culture", i.e. its mostly top-down oriented features, which in the reform process were partially adjusted by including additional institutional stakeholders. The overall hierarchical approach remained and thus did the weak connection between the more and more diverse actors. The concept of fragmented authoritarianism in China's policy decision making (Lieberthal/Oksenberg, 1992) thus remains valid and becomes even more complex with the increasing power of additional stakeholders, e.g. the wealthy regions esp. in eastern China.¹⁶

Top-down continues to dominate: Despite the postulated political purpose to include more expertise in Chinese STI policy, the shaping of opinions even in the diverse sub-circles still works according to traditionally hierarchical modes (a limited number of leaders from government and science dominate, with the latter mostly having double functions both in politics and academia). These tendencies can also be observed when major policy plans and funding priorities are set, as it has manifested itself during the draft process of the Outline of the National Program for MLP (2006-2020) (Rao/Lu/Zou, 2004).

¹⁵ *The S&T policy of China's reform era has always been explicitly ambitious and pragmatic, because the domestic S&T sector has from the beginning been defined as instrumental for the overall national development. This might be the reason why the strong focus on output indicators or institutional rankings in China evolved even earlier and in a more focused way than in other regions in the world (Christmann-Budian, 2013).*

¹⁶ *Regional imbalance adds another important facet to the contemporary Chinese STI system: for example for the different institutional stakeholders, trans-regional relationships are characterized by a small degree of exchange and cooperation. During the last decade the Chinese government has tried to apply inverse strategies for China's western regions. But these efforts have lead to an even more diverse combination of local strategies, development speeds, and currently an even more hybrid picture of the overall development stage in China due to regional lobbying and regional interpretation. As a result, a manifold variety of regional innovation systems within China can be seen.*

Merits and Risks of fast development: Furthermore, while the country was undergoing rapid overall economic, social and environmental changes, the reform strategies and programmes had to be constantly revised and corrected. To a certain degree, this gave the whole process of STI system reform an experimental character. This manifests the respective flexibility of Chinese STI strategies, which, together with the speed of decision-making, are crucial reasons for the great achievements and the general progress of China's STI sector.¹⁷

On the other hand, the issues of sustainability and quality regarding the outcomes of STI policy in China currently are matters of intense debates also inside the country, which shed a different light on the decision making processes.

Appropriate use of funding? This is a weakness of the system which in recent years has also become an observed and hotly debated topic in Chinese policy. Diverse cases of misconduct and systemic dysfunctions lead to a waste of public funding. Review and monitoring processes at several funding institutions still do not ensure the safeguarding and appropriate use of the STI budget. Currently the sector seeks new evaluation instruments, but it certainly faces another challenge when implementing them.

Indigenous Innovation? Another important policy trend in the Chinese STI system is the lasting requirement to accomplish the government's so-called "Indigenous Innovation" concept as one goal of the current MLP (2006-2020). In a way, Indigenous Innovation tries to tackle China's lasting strong reliance on imported technologies, and stands for the political aim to positively shift China's position on the global value chain. But instead of only encouraging domestic innovation, it has also led to various new, protectionist barriers for international technology suppliers as well as for investors (Liu/Cheng, 2011).¹⁸ For these reasons, the Chinese Indigenous Innovation strategy has been interpreted as a "techno-nationalist" programme which aims at assuring China's sustainable competitiveness in the future (Schwaag-Serger / Breidne 2007). But with this strategy the Chinese government has again increased its control over China's innovation resources. The extent of state-funded and government-led mega projects has even surpassed former top-down oriented schemes for the development of certain key technologies. Consequently, Chinese Indigenous Innovation Strategies are a major challenge for international STI exchange and cooperation.

Briefly summarizing the quantitative and qualitative analyses presented above, two main areas for cooperation can be identified: (1) China could be interested to cooperate with the EU in so far comparatively "weak" fields such as "Energy", "Environment", "Health and Ageing", and "Urbanization" in order to gain access to the EU's scientific expertise; (2) Based on the above-mentioned challenges of the Chinese STI system, China could be interested in institutional and framework-related cooperation in order to access the managerial, sociological and methodological knowledge of improving quality and efficiency of its STI system.

¹⁷ Some numbers illustrate already clearly the impressive achievements of the Chinese STI policy during the last decades: The GERD has meanwhile increased to 868.7 billion RMB or 1.84 % of the Chinese GDP (2011) with a previous annual growth rate of 17.9 % between 2005 and 2010. During the same time the funding amount for STI from the Chinese state was already 490 billion RMB (2011). This growth of STI funding growth was accompanied by an immense increase of students (13.5 m undergraduate enrolments/2011), and of the country's capacities of R&D personnel (2006: 1.5 m, 2011: 2.9 m).

¹⁸ By setting domestic technology standards with the claim of universality, implementing public procurement regulations which openly support national or even regional products, local content and similar requirements for foreign investors or the focus on quantitative rather than qualitative patent increase etc., several new barriers have been introduced in the Chinese STI system and the technology markets. Further measures are catalogues which list the key technologies where Chinese IPR should be obtained and those, where imports are still encouraged (Liu, Simon et al., 2011).

2 What do China's scientific strengths and weaknesses mean for Horizon 2020/Grand Challenges?

H2020 encompasses three main pillars such as ES, IL and SC and some other special programmes (see Annex 3). The design of H2020 is strongly derived from a challenge-based and integrated approach. That means on the one hand, SC issues refer only to cross-cutting and integrated approaches¹⁹; on the other hand, a single technology could be linked to all of three pillars (see Annex 4 and 5).

What do China's scientific strengths and weaknesses mean for H2020 /Grand Challenges? Figure 13 demonstrates the result of the matching between China's STI research priority areas and H2020.

Figure 12: Matching China's STI research priority areas with H2020

National Guidelines on Medium - and Long-Term Programme for S&T development (2006-2020)	outcomes of the bibliometric analyses	Matching with EU-Priority / Horizon 2020
Energy		✓ SC
Water and Mineral resources,		✓ SC
Environment,		✓ SC
Agriculture,	strong area	✓ SC
Manufacturing,		
Transportation,		✓ SC
Information industry and modern service industry,	area with large potential	✓ IL+SC
Demographic and health,		✓ SC
Urbanization and urban development,		✓ SC
Public safety,		✓ SC
National defense.		✓ SC
Biotechnology,		✓ IL
Information technology,		✓ IL
New materials technology,		✓ IL
Advanced Manufacturing Technology,		✓ IL
Advanced energy technologies,		✓ IL+SC
Marine Technology,		✓ SC
Laser Technology		✓ IL
Aerospace Engineering		✓ IL

Source: Fraunhofer ISI. (Green: strong areas; blue: areas with large potential)

The important findings are the following:

- Work programmes in H2020 cover almost all of China's STI research priority areas.
- China's improved and potential areas could be a good match with the industrial leadership of H2020.
- China's weak areas could be matched with the Societal Challenges of H2020 to a high degree.
- In general, China is strong in certain individual research areas, but still weak in integrated fields like energy/environment.

This refers to the characteristics/weaknesses in China's STI system: The very narrowly and priority-focused research development according to top-down policies leads to fragmented patterns of competences in basic as well as applied research (except for traditionally strong fields like e.g. Earth Sciences). In other words: relatively strong in

¹⁹ For instance, "Energy" encompasses ICT, energy-related products, services, solution management...etc, a wide range of disciplines.

individual research fields, but still weak in integrating different (sub) disciplines and capability for system building due to the lack of bottom-up approaches in defining priorities on the basis of interdisciplinary exchanges.

3 Why are the EU and China interested in R&I cooperation?

Based on the results of interviews, the motives and objectives of EU-China R&I cooperation seem to be convergent from both sides. The main motives for cooperation highlighted by the interviewees can be grouped into three aspects:

- **To seek excellence in research and STI system** by combining the partners' strengths in terms of knowledge, human resources, research infrastructure and financing. *Especially for China, a stated objective is to source and share knowledge in order to improve its STI system.*
- **To develop new market and business opportunities in China and Europe.** Both sides aim to strengthen their (industrial) competitiveness in the partner country.
- **To tackle common societal and global challenges** such as pollution or ageing populations.

Furthermore, European interviewees view China as a (future) key player in the research and innovation arena with whom Europe should work together– today and in the future. Europe's and China's core competences as seen by the interviewees can be depicted as follows:

Figure 13: Which core competences do the European and Chinese partners bring in?

Europe	China
Competences related to the scientific research system	
Excellence and quality research (in different disciplines)	Excellence and quality research (in different disciplines)
Methodological know-how related to the organization of research: management of research projects and long-time experience with international research collaborations	Availability & quality of human resources esp. young researchers in STEM areas
Advanced STI system & good training systems for S&T	Availability of funding, continuous increase in R&D expenditure
High quality in institutions/infrastructure (well-known universities, world class infrastructure e.g. CERN)	Research possibilities / test fields that do not exist in Europe (e.g. megacities or less restrictive standards/regulations)
European diversity (landscape of research institute & infrastructure)	Different approach, & new ways of generating knowledge
Research ethics	
Competences related to market & business environment	
Innovation capacity & high R&D intensity	Important market
	Very dynamic environment & open attitude towards new technologies, products and services.

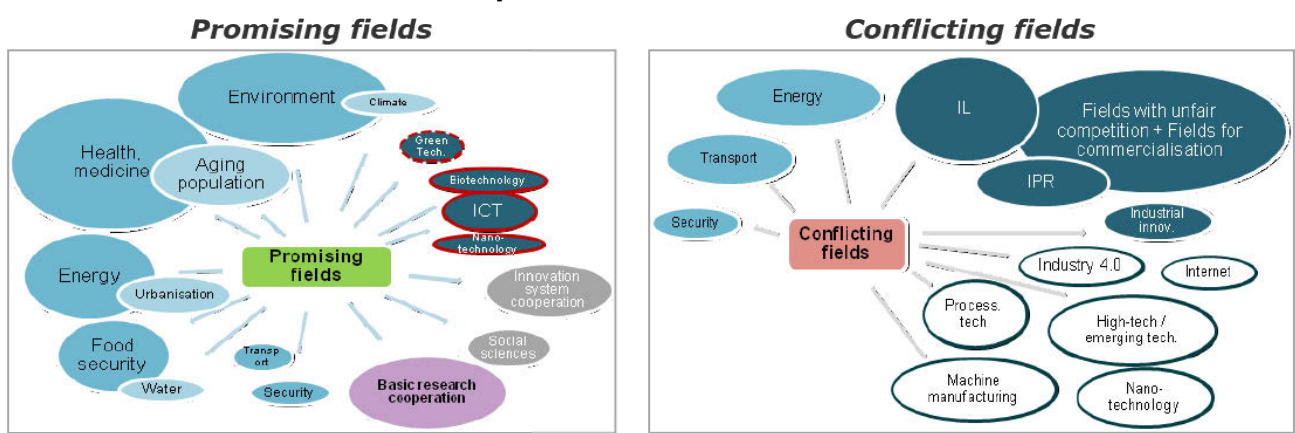
It can be highlighted that European and Chinese interviews have a similar assessment of the partner's competences and their own strengths.

Taking the above-mentioned core competences as the basis for the reflection on the main advantage of EU-China cooperation, the following arguments have been put forward:

- Both sides consider the existence of a political will for cooperation, the already existing cooperation mechanisms and networks in research as a solid basis for further cooperation. On top of that, exchanges of business sectors as well as a stable political and institutional relationship are essential for a promising development in this regard.
- For Chinese interviewees the main advantages are the complementary and mutual interest of the EU and China. Increased EU funding is also seen as an advantage for cooperation with the EU.
- Most of the European interviewees compare the EU-China cooperation to other bilateral research cooperations, especially those with the US. The advantages of EU-China cooperation in comparison to China-US cooperation are seen in the European culture that is said to be closer to the Chinese culture than the "American way". Another argument which has been put forward is the greater political will of the EU to publicly fund global challenges, manifested by the Framework Programmes in the past and its current successor H2020. The current China-US rivalry is also seen as a good opportunity to come into play and extend existing research collaboration. Which are promising and conflicting cooperation fields?

The interviews and the workshop discussions show a remarkable homogeneous picture with regard to the promising and conflicting field of the current and future EU-China cooperation. When clustering cooperation fields according to the three pillars of H2020, it appears that cooperation is qualified as promising in all areas related to the pillar "ES". Basic research collaboration is hence seen as a good field for EU-China cooperation. Similarly, most areas under the pillar "SC" are also classified as suitable for an intensified cooperation in the future. Potential conflicts are seen by both, Chinese and European stakeholders, for areas related to the pillar "IL".

Figure 14: Results of interviews regarding promising and conflicting fields of cooperation



Legend:

- Fields/disciplines related to excellence science
- Fields/disciplines related to societal challenges
- Fields/disciplines related to industrial leadership
- Fields/disciplines related to industrial leadership
- Other focuses

In the workshop the 14 priority areas of Chinese R&I activities (MLP+12th FYP Guidelines) in relation to the three H2020 pillars were discussed. A more differentiated picture on the collaboration potential was generated:

- *Excellence Science*: The potential for cooperation in this pillar must be considered as the largest one of the three H2020 pillars. Here, collaboration is expected to bring benefits to both sides.²⁰ Among the most promising disciplines are: "Environment", "Energy", "Agriculture", "Demographic & Health", but also "Marine Technology" and "New Material Sciences".

Although basic research is seen as an excellent collaboration playground, the discussion highlighted that there is also potential for conflict in this pillar, especially regarding high-technology fields such as "Energy", "Resources", "New Material Technology", "Marine Technology", "Aerospace", "Manufacturing" and "Transportation".

Going beyond the topics defined as priority areas by China, Social Sciences and Humanities have been highlighted in the interviews and during the workshop as areas with little emphasis for the moment, but with increasing potential for future research collaboration.

- *Industrial Leadership*: Not surprisingly, this pillar is seen as a difficult area for collaboration in which topics need to be chosen with care. The reluctance of Europeans to collaborate could be explained by the concept of the "absorptive Chinese state". Although the need for precaution was emphasized by the stakeholders, collaboration in sensitive fields can generate interesting new technology and result in a win-win situation for both partners. "Biotechnology", "Energy", "Aerospace Engineering", "ICTs" and to some extent also "Resources" and "Transportation" seem to be such fields, in which further discussion on the form of collaboration should be envisaged.
- *Societal challenges*: Similar to the "Excellence Science" pillar, the major areas under "Societal Challenges" are seen as favorable for collaboration. The following areas seem to be the most promising for collaboration: "Environment", "Urbanization" and "Agriculture", but also "Energy", "Transportation", "Demographic and Health" and "ICTs". Like in the IL-pillar, the topics under SC can include high technology aspects and one should be aware that conflicts could arise. While future problems should not limit the will for cooperation, the development of instruments to solve these conflicts (e.g. common innovation criteria) should be envisaged.

Although there are some apparent areas in which both partners are reluctant to collaborate, the overall picture shows a call for further research & innovation cooperation between Europe and China.

4 What are the hindering factors for closer cooperation?

Interviews and group discussions point out the following barriers to EU-China cooperation.

²⁰ *Almost all of the experts agree that cooperation in ES is the promising and easiest one due to the nature of scientific research (openness, exploration of new knowledge). Several reasons were mentioned: 1. win-win-opportunity, 2. small degree of conflicting issues in the cooperation on this level, 3. many established best practices for cooperation patterns (jointly defined cooperation fields, joint calls, joint peer review, joint post-evaluation)*

Barriers related to research cooperation

Administrative procedures related to research funding mechanisms

- Unclear and complicated funding rules, including work-intensive applications for joint calls
- Lack of reciprocity in research funding, especially Europeans miss the willingness from the Chinese side to create cooperation instruments equivalent to H2020.
- No synchronization of funding calendars
- Low level of transparency with regard to the selection criteria for projects
- Limited understanding of funding agencies' administrative procedures
- Low success rate of EU-funding
- Funding agencies' arrogance towards applicants

Restricted mobility of researchers

- Cumbersome visa procedure for Chinese researchers
- Insufficient attractiveness of research institutions in continental Europe and China for a research career (in comparison with the US, UK or Australia). Also related to the lack of knowledge on the partner's research capacity.
- Lack of language skills: China is not very visible to Europeans due to non-English publications or communication channels.

Different research culture

- Different research culture and (quality) standards
- No common evaluation criteria
- Different research priorities.

Barriers related to Business & competition aspects²¹

- Not sufficient enforcement of IPR in China
- Limited joint standards and codes of conduct
- European concern about the politically controlled economy in China and competition by state-owned companies
- Limited protection of high technology and risks of technology leakages

Barriers related to legislation and other political factors

- Different administrative cultures making understanding difficult
- Lack of trans-institutional exchange & dialogue
- No real EU-China bilateral cooperation schemes, e.g. a multi-annual funding on an equal partnership basis
- Not yet a clear joint strategy & action plan of EU and its Member States towards China: this results in a lack of inner-European coordination with regard to China, no common priorities for research collaboration with China (including the definition of no-go areas), lack of clear knowledge of EU Member States actions with China.

²¹ Interviews and all workshop groups identify "competition" as a big concern.

Barriers related to cultural factors

Although this aspect is mentioned last in this list, all participants of the workshop and interviews named this aspect as a very important hindering factor. It includes:

- Different perception and understanding of "technology cooperation" and a different attitude towards new technology and risks;
- Lack of language skills. This is especially a barrier for Europeans who want to do research and live in China. Due to lacking Chinese language skills, China is not very visible to Europeans
- Lack of knowledge of the capacities & potential of the partner. Again this is especially true for Europe. Here, undefined concerns about China combined with limited knowledge about China are hindering factors for taking up collaboration.
- Different values: this does not affect only the research culture (above), but also the daily life with which Chinese and Europeans are confronted during their stay in the partner country.

5 How to intensify EU-China research and innovation cooperation?

According to the interviews with important EU-China stakeholders and discussions at the workshop, two dimensions of political recommendations can be made. The first one refers to the improvement of cooperation framework conditions for efficient and effective cooperation. The second one refers to the concrete political measures for different programmes within H2020.

5.1 Dimension one: to create appropriate and effective framework conditions for effective and efficient cooperation

With regard to the first dimension, six aspects for closer EU-China cooperation are summarized: "Principles", "Who talks to whom?", "How to set up strategic priorities?", "Improvement of efficiency and coordination of administration", "Creative cooperation forms/instruments" and "Funding issues". Under each aspect the experts made a variety of suggestions. In some aspects the examples of "best practice" are listed to inspire more creative ideas.

1. Principles

- Willingness/interest to increase the mutual (cultural/political) understanding
- Principle of equality, mutual interests and complementary advantages
- Mutual respect; To be willing to find compromises for regulations
- To develop joint mechanisms / joint rules/ joint calls with joint funding
- To share the research results and IPR
- Flexibility; to simplify the rules

Regarding mutual understanding, most of the European experts agree that the EU needs a more cultural sensitive approach towards China; the EU should know more about China regarding the key actors and the scientific performance. In their opinion, China is mutually supposed to accept its new role and new responsibilities in the international community. By contrast, from the Chinese side "equality", "respect" and "flexibility" are emphasised. Different perceptions by both sides could be seen.

2. Who talks to whom? Who makes which decisions?

- To set up one direct core task force for the cooperation communication
- To clarify the role among ERC, DG RTD as well as other DGs and SFIC from the EU side and the role among NSFC, MOST, CAS, MOE from the Chinese side. The aim is to match administrative agencies of both sides for efficient communication channels.
- To clarify the tasks of the European Commission and EU delegation as well as S&T counselors of EU MS in China and the tasks of MOST and other Chinese stakeholders: to promote, explain and enhance the understanding of both sides
- Early communication

The role and function among different official authorities within both the EU and China are not well defined. The communications are running suboptimal. Many misunderstandings arise.

3. How to set up strategic priorities?

- To formulate a strategic cooperation: to identify joint goals, interests and the cooperation research priorities, esp. where no country has the leading role.
- To create an advisory body to formulate strategies and programs
- To be more pro-active from the EU side towards China's STI development
- To develop an effective "China strategy" of the EU/ EU needs to act with one voice

- To promote a more federalized EU
- To foresight and coordinate the EU agenda and MS national priorities/ to create and use exchange platforms EU MS
- To select fields for collaboration (setting up focuses); To do a mapping exercise which activities already exist in Europe
- To define fields in which cooperation is wanted and in which not especially considering the aspects of competition and technology captivation
- To explain the added value of working with China better and more clearly
- To learn from EU MS
- Consulting with EU MS and involving MS into the decision process
- Bottom-up approach of building on experience and knowledge of MS which look upon a long tradition of cooperation with China

Best practices initiatives of MS e.g. four MS multilateral call on SSH, joint calls with NSFC

China is interested in cooperating with the EU in the pioneer research areas where neither the USA nor Japan has the leading role. By contrast, there is a large diversity of opinions among the Europeans. Therefore, the request for a concrete and common Chinese strategy from the EU side is loud.

4. Improvement of efficiency and coordination of administration

- To simplify the application procedure
- To provide training of middle level administrative agencies on both sides for improved exchange and realisation of measures: e.g. rule understanding, information spreading, application procedure acceleration.
- To plan/monitor/evaluate calls jointly: work-intensive but mostly positive experiences
- Best practice
 - ERC: less bureaucracy, active promoting H2020 at Tsinghua University in China

"Simplification of the rules", "improved administrative skills" and "jointly working" between both sides are the key messages.

5. Implementation of (creative) cooperation forms/instruments

- To conduct different innovation cooperation dialogues/ cooperation agreement with high political level further under the already existing framework (See Annex 6)
- Openness to new/creative cooperation forms/schemes
 - To create a new "EU-China research council"
 - Institutional cooperation e.g. cooperation of ERC and NSFC
 - To enlarge scale of cooperation (big cooperation case USA: projects with larger funding scale)
 - Development of joint standards/common codes for research integrity
 - Cultural and language courses included in project funding
 - Implementing gender balance in research team, esp. in the EU
 - To build research and innovation evaluation for more benchmarking between the research institutions of both sides
 - Cluster cooperation
 - Twinning of existing projects
- Best practices
 - Partnership instrument used by the EU Delegation in China
 - ERANET schemes
 - PPP (e.g. on 5G in China) & JPA
 - Creative cooperation forms to increase mutual understanding: French "Tour de Chine" as well as "Zhang Heng Scheme" (both for enterprises) or RCUK (UK), Competitive Cluster Scheme (France)

A variety of innovative ideas could be seen in this section. Principally there are two different opinions: the one is to maintain and make use of the existing framework; the other one is to create a new institution e.g. EU-China Research Council for better cooperation management.

6. Funding issues

- Equal access to national funding / principle of equality
 - Mutual access to R&I funding: H2020 is open to the world. China should also open its funding programmes for more European participation
 - Announcement of financial commitment from both sides
 - Joint funding at program level
- Enhanced mutual understanding of administrative procedures related to funding
 - Training of admin staff on both sides
 - Better and early communications to understand the rules and conditions
 - Transparency
 - Exchange also on funding level agency / create networks of administration
 - Shorter communication ways
 - Synchronize funding calendars between EU & China

At the policy level regarding funding, both sides require the "equality"; at the implementation level the efficiency of administrative agencies should be improved.

5.2 Dimension two: possible political measures for three pillars ES, IL and SC under H2020

Some suggestions from the experts could be directly categorized into three pillars ES, IL and SC under H2020.

Political measures for improvement of cooperation in "Excellent Science"

- Openness of basic research schemes on both sides:
 - Cooperation agreement between ERC und NSFC
 - Opening the ERC schemes to joint collaboration initiatives with China
 - Open 973 to cooperation with ERC
- Elaborate / Intensify joint (multilateral) research structures
 - Joint labs/virtual labs/joint research centres & universities
 - Shared open access to research data
 - Best practice examples: INCO Labs; Living Labs, ITER, ORA-Model, DFG-NSFC-AKA, FWF-NSFC, SNSF-MOST
- Enhancing mobility and exchanges of scientists, esp. young researchers ("early career mobility")
 - e.g. half-year sabbaticals for researchers within joint labs, (support of) multilateral calls
 - Initiatives/platform for young researchers for networking, project matching and realisation
 - Identifying partners and projects. (e.g. via focused symposia, esp. combined meetings of researchers and scientific administrators)
 - Best practice examples:
 - Marie Curie scheme
 - e.g. France has own mobility budget that is co-funded with China

Scholarship Council

- French "Xu Guangqi" scheme and "Cai Yuanpei" scheme

More student exchanges in higher education on both sides e.g. joint doctoral schools by CLUSTER universities and Chinese universities; joint degrees; EASE European Academy and scientific explainers "SASE-Shanghai Academy"

"Openness" is the universal principle in basic research areas. The motives and interests of researchers are driving forces for cooperation. Hence a bottom-up approach is appropriate to encourage basic research cooperation. That means the authorities should create a sound environment for scientists to access relevant information, to exchange with each other, to find out the cooperation partners and cooperation topics. Through the closer cooperation especially among young researchers on both sides, the capability of cultural, mental and language understanding will be raised and trust and even friendship on both sides could be established. These "soft" factors, say, trust and friendship are the basis for closer and long term cooperation.

Political measures for improvement of cooperation in "Industrial Leadership"

- Providing a positive environment (e.g. opening up the Chinese market)
- Increase high policy dialogue on IPR-issues (e.g. EU-China IPR Treaty; Enforcement of IPR laws in China; creating common standards)
- Support for SMEs (platforms for exchange according to branch/technology field)
- Joint funding for pilot line and prototype; instruments for financing "seed-start-incubator"; go co-commercialisation
- Exchange platform such as business plan competitions
- French Scheme "Decouverte la Chine" and "Zhang Heng Scheme"

In "industrial leadership" it is not easy to find out suitable cooperation models. IL refers to technology/innovation cooperation which comprises knowledge transfer, technology transfer, patent licensing (key word: IPR), technology deployment, market chances and has a focus on cooperation between research organization and industries. The goals are oriented towards benefit, value-added and are related to enhancing industrial competitiveness. However, cooperation is principally needed for both sides in order to profit from each other and to monitor each other regarding industrial expertise. Based on experts' views, both "coop. chance" and "conflicting" exist in IL. The conflicting aspect will appear especially in the long run, when the industrial level in China is further upgraded. Therefore a finer and more cautious design for IL cooperation is necessary, esp. for the EU side. The essential issue is IPR.

Political measures for improvement of cooperation in "Societal Challenges"

- Basically all topics meet Chinese demands
- To make a concrete strategic plan for the issue "sustainable urbanisation" under H2012 by top level experts
 - To clarify different concepts using identical wording; to clarify the relationship among numerous stakeholders within this big issue
 - To set up priorities
 - To develop strategies and approaches for different priorities
 - To define research projects very concretely
- Cooperation in Societal Challenges should happen on the project to project basis; to this end, specific programmes (calls) are needed.
- More pilot research to explore new possible cooperation
- To keep the social sciences/humanities in focus to guarantee substantial interdisciplinary exchanges on societal challenges

China is keen to cooperate with the EU in this SC area. Both sides should jointly develop an effective and efficient model for "governance of GC Innovation".

6 Conclusion

A high potential of cooperation exists between the EU and China under H2020. The promising areas could be identified in ES and SC, esp. in ES. The key question is how to cooperate with each other. In order to deal with this question, the EU has to integrate the different interests, priorities and approaches among the MS. Two different principles could be observed among experts' views in this regard. The first one is to apply the already existing framework of the EU, but to strengthen the coordination between relevant agencies and the EU MS. The second one is to create a new "EU-China research council" for a direct, efficient and effective decision procedure and R&I governance.

This idea of the second principle could be interpreted as follows: Similar to the Sino German Center for Research Promotion of NSFC and the German DFG, this institution should have its own (matching) funds from both partners, its own portfolio and jointly created application and review procedures (managed by staff from both sides). By that, the interaction between this EU-level-institution and the relevant institutions of the EU MS would be easier. For the Chinese side which might get involved in such a joint institution, this would provide an unprecedented insight into the ERA's mechanisms.²²

With this kind of specialized funding organization as "One Task Force" all processes including a rigid quality audit could be integrated. Furthermore, it would raise international attention, much more than single calls etc. It could also constitute a platform to continue the dialogue between EU and China to work on topics like evaluation processes/methods, research integrity etc.

This institutional consideration might be the foundation for further and closer cooperation between the EU and China since learning effects could be transferred to further fields.

²² *Since Chinese government has encouraged Chinese research organizations to become active abroad recently, it is worth for the EU trying to find a Chinese partner who is willing to establish such an institution **in Europe**.*

7 Abbreviations

AKA	Academy of Finland
CAS	Chinese Academy of Science
CERN	European Organization for Nuclear Research
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
DG	Directorate General
FWF	Austrian Science Fund
EASE	European Academy and scientific explainers
EC	European Commission
EFFLA	European Forum on Forward Looking Activities
ERA	European Research Area
ERA-NET	European funding scheme (Framework Programme 7) for cooperation and coordination
ERC	European Research Council
ERIAB	European Research and Innovation Area Board
ES	Excellent Science
EU	European Union
FYP	Chinese Five-Year Plan
GC	Grand Challenges
i4G	Innovation for Growth (European expert group on Research and Innovation policy)
ICT	Information Communication Technology
IL	Industrial Leadership
INCO	EU programme on International Cooperation Research activities
IPR	Intellectual Property Right
ISI	Fraunhofer Institute for Systems and Innovation Research
ITER	International Thermonuclear Experimental Reactor
JPA	Joint Program agreement
MLP	National Guideline on Medium- and Long-Term Programme for Science and Technology Development (2006-2020) (China)
MNC	Multinational company
MOE	Ministry of Education (China)
MOST	Ministry of Science and Technology (China)
MS	Member States
NSFC	National Natural Science Foundation of China
ORA	Open research area
PPP	Public Private Partnership
PRC	People's Republic of China
R&D	Research and Development

Abbreviations

R&I	Research and Innovation
RCUK	Research Councils United Kingdom
RTD	Research Technology Development
SASE	Shanghai Academy of Scientific Explainers
SC	Societal Challenge
SFIC	Strategic Forum for International Science and Technology Cooperation
SME	Small and medium enterprises
SNSF	Swiss National Science Foundation
SOE	State-owned-Enterprises
SSH	Social Sciences & Humanities
STEM	Science, technology, engineering and mathematics
STI	Science, Technology and Innovation
UK	United Kingdom
US	United States
USA	United States of America
WTO	World Trade Organisation

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9 Annexes

Annex 1: Interview guidelines

Interview Guideline

1. Aims of EU-China cooperation
 - In your view, which motives are decisive for EU-China cooperation?
 - Which objectives are typically pursued? Within what kind of (project) framework?
 - Which core competences do the European and Chinese partners bring in?
 - Which main advantages does the EU-China cooperation have in comparison with other international cooperations?

2. Main fields of cooperation
 - In the light of the new Horizon 2020 framework and the Grand Challenges addressed through research and innovation: What should be the main thematic dimensions where a (increased) cooperation between EU and China is expected to lead to the most desirable results?
 - Are there any conflicting interest fields?
 - Do you see new fields of cooperation for the next few years?

3. Realisation
 - How could the EU and China intensify their R&I cooperation?
 - What framework conditions / measures / instruments are best suited in order to reach the cooperation goals?
 - What are the promoting and hindering factors for an intensified EU-China cooperation?

4. Outlook
 - Based on your personal experience, what kind of action is needed for a successful cooperation between Europe and China?
 - Which next steps would you define in order to improve bilateral cooperation in (applied and basic) research – to be undertaken by policy-makers but also with regard to the single R&D projects?
 - How do you see the future of the European-Chinese Research collaboration?

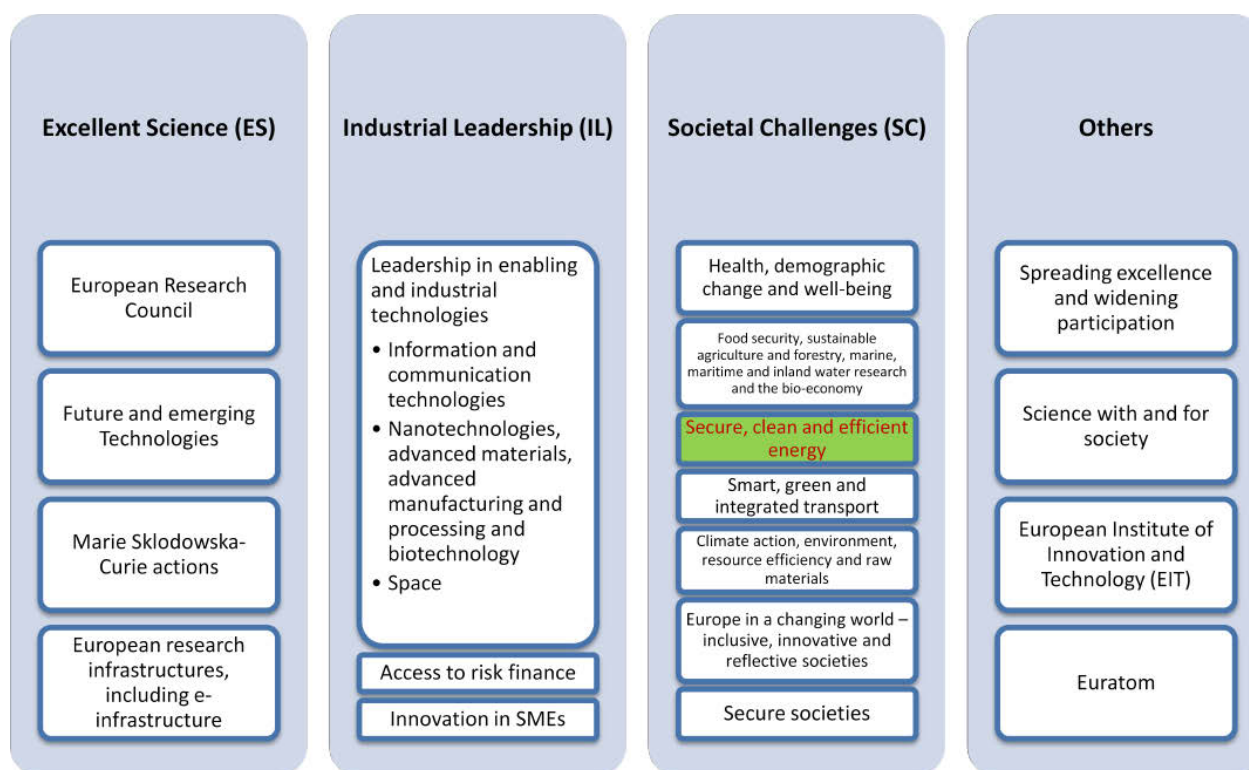
Annex 2: STI policy plans and goals in China

Policy Plans	Goals	Wider research / innovation fields	Time frame	Institutional affiliation
National Guideline on Medium- and Long-Term Program for Science and Technology Development (2006-2020) / 国家中长期科学和技术发展规划纲要 (2006-2020年)	Main policy document for S&T and innovation of this policy period in China; major goals are: enhancing China's GERD to 2.5 percent in the plan period, the reduction of dependence on foreign technologies by 30 percent, science and technology contribute 60 percent to national development by 2020, China occupies the 5th place in number of patents and citations of Chinese scientific publications worldwide. General goal to become one of the leading scientific nations of the world by 2050.	all fields	2006-2020 (11th-13th FYP)	State council policy, MOST, NDRC, MOE, MOF, all sectoral and regional agencies involved
12th Five-Year Plan for the development of science and technology (2011-2015) 国家"十二五"科学技术发展规划	Some key objectives: - A substantial increase in R & D intensity, GERD increase to 2.2%. Basic research and cutting-edge technology research investment continues to increase, significantly enhance corporate R & D investment, further expand investment and financing channels for technological innovation; - S&T management reform to make significant progress.	all fields	2011-2015	MOST document
12th Five-Year Plan for the Strategic Emerging Industries (2011-15), "十二五"国家战略性新兴产业发展规划	Seven industries are to be developed: energy saving and environmental protection industry, new generation of information technology industry (partially including photonics), bio industry, advanced manufacturing industry, new energy industry, new materials industry (partially including nanotechnology), and new energy vehicles (not completely identical with KETs, but large overlap)	emerging industries	since 2009; current 12FYP policies	State council strategy, MOST and NDRC coordinate
Key Technologies R&D Program (国家科技攻关计划; since 2006:	Program contains clear top-down priorities according to the development of (politically defined) economic and social needs with	Applied technology research and	Since 1982 - ; some modification/	National level; MOST coordinating

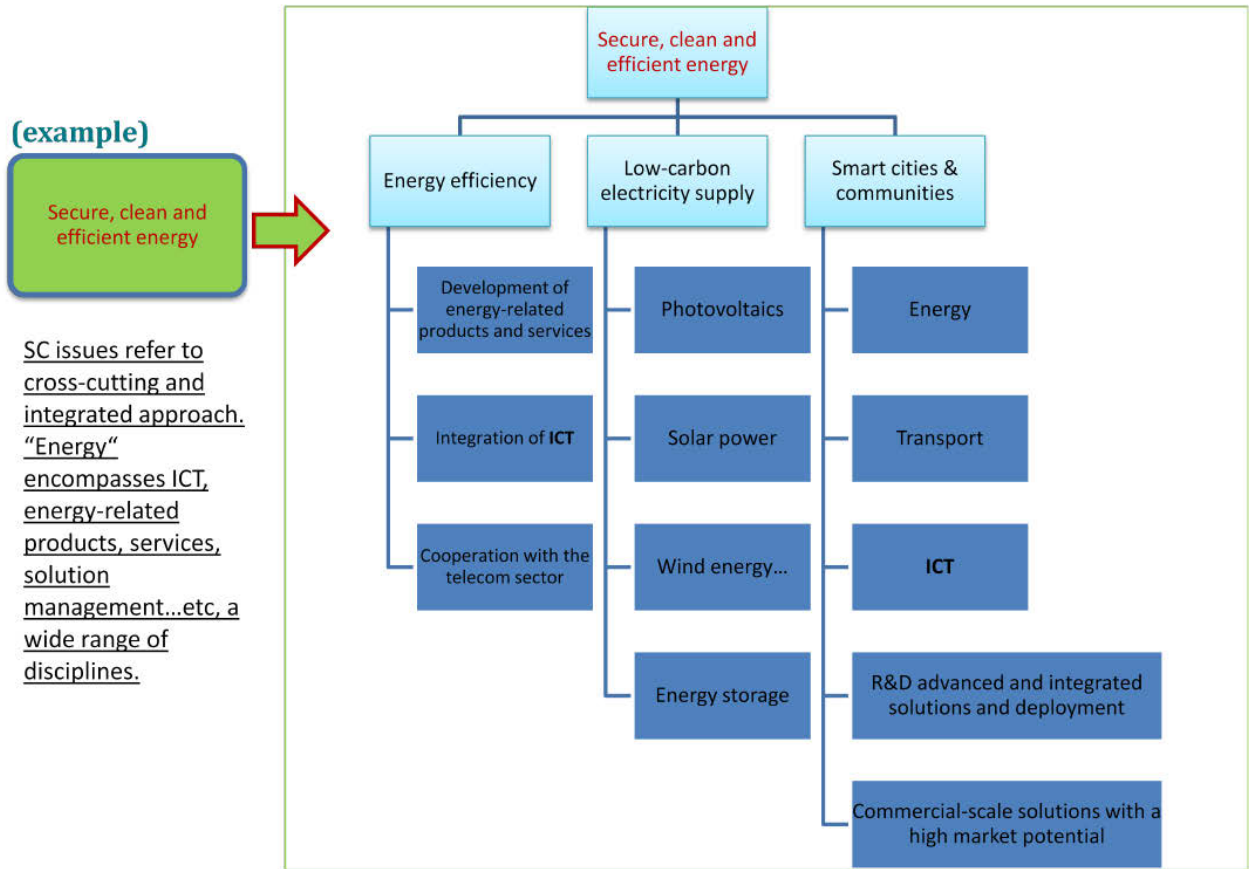
Policy Plans	Goals	Wider research / innovation fields	Time frame	Institutional affiliation
国家科技支撑计划)	focus on commercially exploitable research fields areas; these research fields are adjusted with each Five-Year-Plan and therefore some fields remain the same, while others can be dropped or added again according to political needs.	development with social / industrial application; priority fields according to current FYP/MLP	ns (incl. program title) in 2006	supervising institution
863 Program / 高技术研究发展计划 - 863 计划	Medium-to long-term strategic funding program, aims at providing development guidelines and support for selected high priority technologies, areas in order to increase China's international competitiveness in these fields and develop R&D capacities in high technology; during 12th Five-Year Plan major tasks to advance cutting-edge technologies (MLP) and to address fields of national long-term development and national security, as well as to foster strategic emerging industries;	Cutting edge technologies, (strategic) emerging industries	Since 1986	MOST coordination
'National Key Basic Research Program' or 973-Program, 国家重点基础研究发展计划 / 973 计划	Like its predecessor, the Climbing Program, the 973 Program supports the development of basic research in selected key research areas. It comprises strategic research within the framework of defined areas with future social / economic impact comparable to other major R&D schemes. Another goal is to train qualified S&T personnel in China.	("Applied") Basic/Strategic Research	Since 1997	MOST coordination ; NSFC review
Major Key Project	Major part of MLP according to 12 FYP goals until 2015: Beginning to achieve leapfrog development momentum, achieved manned spaceflight, lunar exploration, supercomputers, super hybrid rice, high-speed railway, the experimental fast reactor, quantum communications, iron-based superconductors, manned diving,	"Big Science" initiative	Stepwise establishment since 2006, - 2020	MOST, NDRC, MOF, resp., sectoral and regional agencies ...

Policy Plans	Goals	Wider research / innovation fields	Time frame	Institutional affiliation
	induced pluripotent stem cells			
Innofund Program / 科技型中小企业技术创新基金	Innofund Program for SMEs is a special program to support high-tech SMEs with an emphasis on the seven strategic emerging industries; the goal is to support SMEs in bringing their innovative ideas to the market, focusing on the commercialization phase of their R&D developments. The funding volume per innovation project is a maximum of 250,000 euro.	SME innovation initiative	Since 1999	MOST/NDR C

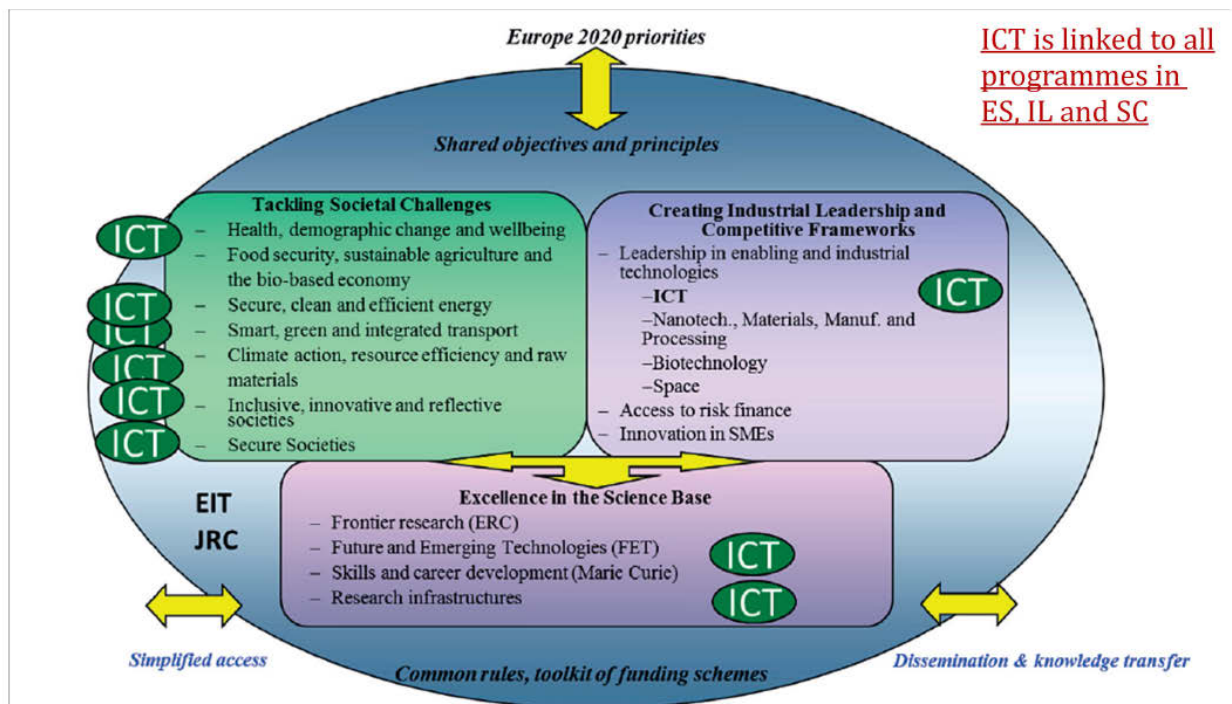
Annex 3: Structure of H2020



Annex 4: Challenge-based and integrated approach in SC



Annex 5: Interlinked technology under H2020



Source: https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/ICT%20in%20H2020%20WP2014-15_0.pdf

Annex 6: EU-China cooperation mechanisms at the current stage

	Sustainable Development							Prosperity			Others : e.g. Framework conditions	
	Energy	Urbanisation	Climate change and environmental protection	Space+Aerospace	Ocean	Regional policy	Social progress	Public policy	Agriculture	Industry and ICT	Transport and infrastructure	People-to-people exchanges
China-EU 2020 Strategic Agenda (Beijing Nov. 2013)	Policy Dialogue											
	X		X (water policy dialogue)	X		X			X	X		X
Other mechanisms	Roadmap for China-EU energy coop.; EC2: pilot projects	EU-China Urbanisation Partnership Forum; China-EU City Expo; Mayors' Forum; Demo-cities	under international cooperation framework e.g. UNFCCC and ist Kyoto Protocol; Strategic plan 2011-2020 of the Convention on Biological Diversity and the Convention on international Trade in Endangered Species of Wild Fauna and Flora; EU-China Water Platform					Round Table between the China Economic and Social Council and the European Economic and Social Committee.			the Letter of Intent on cooperation in the field of civil aviation between CAAC and DG MOVE (signed on 23 Aug 2013)	China-EU Youth Policy Dialogue; China-EU Symposia on Youth Work Development; China-EU Youth Partnership for Friendship Programme + EU Youth Actions under Erasmus+
1st meeting of EU-China Innovation Cooperation Dialogue (Beijing, 21 Nov. 2013)		city planning, green transport, clean technology, sustainable energy		joint initiative on aviation (foreseen: joint calls for research and innovation projects)					Launch of new flagship initiative on Food, Agriculture and Biotechnology	Further development of framework for cooperation in industrial innovation (closer collaboration in business, research, innovation); key topics: future telecommunication		Promotion of predictable, transparent, effective framework conditions related to innovation; Expert Task Force on Innovation Cooperation (goals: promote successful practices, reporting)
others		EU-China Urbanisation Workshop (may										