INSTITUTE FOR EUROPEAN STUDIES

EL-CSID European Leadership in Cultural, Science and Innovation Diplomacy

Working | paper

The EL-CSID project is coordinated by the Institute for European Studies (IES)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 693799.

Innovation diplomacy caught between the two opposing logics of cooperation and competition: Case study on EU-China S&T cooperation in the field of solar PV

Daniel Gehrt
Joint Institute for Innovation Policy (JIIP)

Issue 2018/15 • April 2018

Table of Contents

1 Introduction 3

2 Background: The decline of the European solar PV industry and the role of China in this context 5

3 Opportunities and threats of EU-China collaboration in the field of solar PV 7

3.1 Opportunity 1: Generally assumed benefits of international S&T cooperation 7

3.2 Opportunity 2: Climate action and energy security as global challenges on which the world should work together 8

3.3 Threat 1: Solar PV as a mature technology in an extremely competitive market 9

3.4 Threat 2: Specific issues with regard to R&I collaboration with China 9

4 The EU's framework for S&T cooperation with China 11

4.1 General framework of the EU's S&T cooperation with third countries 11

4.2 Specific agreements for S&T cooperation between the EU and China 13

5 Analysis of the EU's reaction to the solar PV issue 16

5.1 Analysis of official documents and agreements 16

5.2 Analysis of *Horizon 2020* topics 17

5.3 Analysis of interviews conducted with relevant EC officials 20

6 Discussion, conclusions and outlook for further research 23

6.1 Discussion and conclusions 23

6.2 Outlook for further research 24

7 Bibliography 25

1. Introduction

In recent years, the European Commission and in particular its Directorate-General for Research and Innovation (DG RTD) have increasingly promoted the concept of ***science diplomacy*** as a means to yield ***soft power*** in the European Union's relations with other countries and world regions. One recent document in which this idea is prominently mentioned is the vision paper ***Open Innovation, Open Science, Open to the World***. It defines the fostering of international collaboration in research and innovation "as a strategic priority for the European Union so that we can access the latest knowledge and the best talent worldwide, tackle global societal challenges more effectively, create business opportunities in new and emerging markets, and use science diplomacy as an influential instrument of external policy"[1].

It should be noted here that the way in which the European Commission uses the term ***science diplomacy*** is in fact somewhat vague. Overall, it tends to refer to the support for research & innovation (R&I) collaboration with other countries and world regions through the conclusion of science and technology (S&T)[2] agreements, co-funding mechanisms, inclusion of other countries in own funding programmes, support to networking activities and similar types of tools.[3] The expected benefits of this are many-fold. First of all, it means being at the forefront of scientific discovery, which in turn is seen as a pre-condition for economic competitiveness. Second, there is the argument that "global challenges require global solutions", referring to issues such as climate change, infectious diseases and food as well as energy security, for example. Third, there is the idea that good relations between the research and innovation communities of two countries will also be beneficial for the overall relations between these countries.

The above understanding of ***science diplomacy*** relies on an (implicit) assumption that collaboration in research and innovation is generally beneficial for both sides, i.e. that there is a win-win situation for all actors involved. While this may be true for "pure" science-related collaboration which is still relatively far from actual application and/or market-ready products, the question is to what extent this can also be assumed for research and development that is close(r) to the market and where commercial interests, and therefore competitive thinking, are likely to come into play. Or, to put it differently: Can the idea of ***science diplomacy*** be transferred to the realm of innovation and can we usefully speak of something like ***innovation diplomacy***?

The purpose of this study is to test this question on the basis of a highly interesting illustrative case. It concerns the domain of the solar photovoltaics (solar PV) and the competition between the EU and China in this field. In fact, the decline of the European solar PV industry and the role of China in this context is quite a dramatic episode of recent economic history. Europe being in a leading position up until the late 2000s, China suddenly managed to not only overtake Europe as global leader but to effectively destroy large parts of the European industry with an overabundance of PV products being sold at prices with which European producers could simply not compete. All of this happened roughly between 2008 and 2012, i.e. within a time span of less than five years. Anti-dumping measures put in place by the EU have only resulted in counter-measures by China and have overall not helped redress European solar PV industry.

---

[1] European Commission, 'Open Innovation, Open Science, Open to the World: A Vision for Europe', 2016. P. 59.

[2] The terms "science and technology (S&T)" and "research and innovation (R&I)" are often used interchangeably. For the purpose of this study, we will use the term "S&T" primarily in the context of S&T ***cooperation*** at policy level between two countries and the term "R&I" primarily in the context of actual R&I ***collaboration*** "on the ground" between specific research organisations.

[3] This understanding of the term is in fact quite different from the one used in other contexts, where it refers for example to situations characterised by a stalemate of the official diplomacy between two countries and where scientists help continue the dialogue, making use of the universal, non-ideologic and non-partisan character of science. This understanding of science diplomacy has also been coined ***science for diplomacy*** by the American Association for the Advancement of Science (AAAS).

In the eyes of many, the key to rebuild at least some of the European PV industry and to save what is still remaining of it, lies in innovation. As European producers cannot compete on price, they must be more innovative, developing new technologies that are more efficient and can serve new application areas. In order to support this, strong efforts are being made by the European Commission and others to review and tune their (PV-related) R&I policy instruments specifically with this goal in mind. These instruments shall enable European producers to develop and exploit knowledge which Chinese (and other) producers do not have and to regain a competitive advantage through this.[4]

It is quite clear that there is at least a difference in spirit between the two approaches of (a) the very competition-oriented view on innovation as a tool to strengthen one's own industry and to get an advantage over others on the one hand and (b) the philosophy of "Open Innovation, Open Science, Open to the World" on the other. An additional and very interesting aspect here is (c) the fact that the solar PV can help at least two global challenges, namely energy security and climate change, which, according to the European Commission, should be another motivation for international collaboration.

The question is therefore whether the above-described strong competition between Europe and China in the solar PV field is reflected in the EU's science diplomacy towards China. This can concern formal agreements between both sides, but it can also manifest itself in more subtle ways (of which diplomacy knows very many of course). The present case study undertakes an in-depth examination of this question, look for evidence that either supports or contradicts such a hypothesis and, if supportive evidence is found, also analyses to what extent and in which way this plays out exactly.

[4] The author of the present paper was involved in a large-scale study that is supporting DG RTD precisely in this effort.

2. Background: The decline of the European solar PV industry and the role of China in this context

As already stated in the introduction, the decline of the European solar PV industry and the role of China in this context constitutes quite a dramatic episode of recent economic history. While Europe had been in a leading position up until the late 2000s, China suddenly managed to not only overtake Europe as global leader but to effectively destroy large parts of the European industry with an overabundance of PV products being sold at prices with which European producers could simply not compete. All of this happened roughly between 2008 and 2012, i.e. within a time span of less than five years. The aim of this section is to give a brief summary of this development, as it provides the background for the rest of the study.

Until the year 2007 approximately, the European solar PV industry was in a leading position, with a global market share of around 30%. One of the reasons for the strong PV production were, amongst others, strong demand-side policies in various European countries. These were started by the German government, who introduced a very attractive guaranteed feed-in tariff for electricity generated by privately owned solar PV installations in 2000. Similar measures in other European countries followed shortly after. This, together with steadily decreasing costs for solar PV modules, led to an unprecedented surge in demand. For a number of years, the majority of this demand was fed by European-produced PV modules. On this basis, the European solar PV industry was booming.

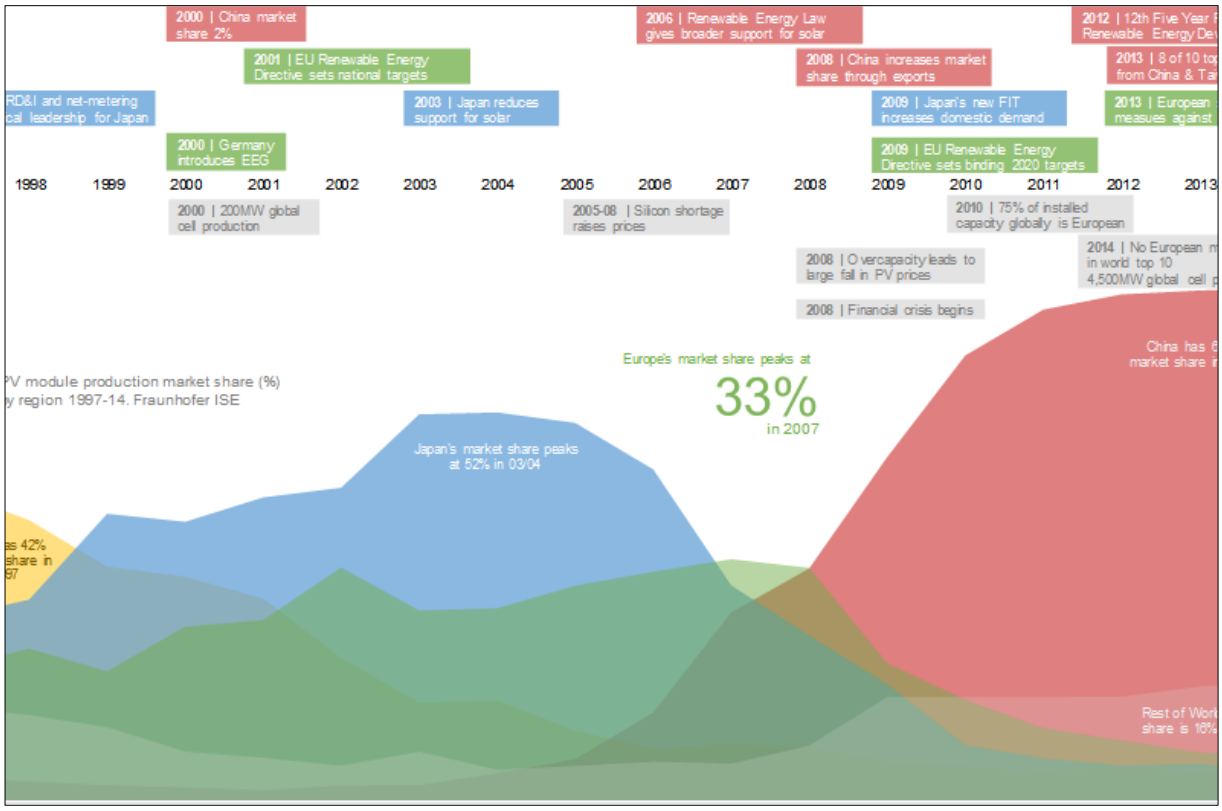
The situation changed relatively suddenly, due to a combination of various factors and events. First, a shortage of polysilicon, the key raw material for solar PV cells, arose in 2004 and lasted until 2008. This meant that European manufacturers were obliged to procure polysilicon at very high prices, which obviously inhibited them from making investments in the upgrading (size- and/or technology-wise) of their production capacities. At the same time, the situation was very different in China. Helped by high foreign direct investments, Chinese companies were able to make significant investments in the increase of their production capacities. But not only this, they also invested in IP (in form of patents) from established manufacturers in Europe, as well as in increased own R&D activities.

When the polysilicon shortage ended in 2009, Chinese production could go full steam and fill a large gap between steeply increasing European demand on the one hand and the only slowly increasing European production on the other. This gave Chinese producers the chance to prove the quality of their products and to show that there was no substantial difference compared to European products. Some of the European producers were also still bound to so-called “take-or-pay” contracts for polysilicon, which they had entered during the period of polysilicon shortage. This meant that they had to continue buying polysilicon at high prices or pay fines, whereas other competitors, in particular new entrants from China, were not exposed to this constraint. A third factor started hitting European producers on their home markets, which was the fact that, as a consequence of the financial crisis, several governments significantly reduced or completely withdrew favourable feed-in-tariffs or even introduced retroactive taxation, which obviously reduced demand significantly.

In 2008, China overtook Europe in terms of production output and sales worldwide. All these developments then led relatively suddenly from a global undersupply to an oversupply, resulting in strong price cuts. While this was obviously a big challenge to many European producers, Chinese companies had access to substantial debt financing deals and loan guarantees from 2010 onwards, which helped them sustain themselves and to grow production capacities even further. The prices of Chinese solar PV panels, with which European producers could not compete, eventually led to EU anti-dumping duties on Chinese solar panels in June 2013. In August of the same year, an agreement was reached that limited the imports of Chinese solar panels and set a certain minimum price.

However, in can be said that at this point the European PV industry had already "lost the battle". By 2014, Chinese producers had reached a share of global production of 69%. While in 2004, five out of the world's top 10 producers of solar PV manufacturers were European, not a single European producer remains in that list today. With very dramatic consequences in terms of European jobs: According to an estimation by Ernst & Young together with Solar Power Europe, 59,000 people were employed in solar PV production (upstream only), of which only remained 15,000 in 2014.[5, 6]

Figure 1: Timeline of events affecting market shares of leading countries in solar PV industry (Source: "Assessment of Photovoltaics" study [7])



As most recent analyses show, the above-described trend has continued until this date.[8]

[5] Trinomics, DNV-GL, PricewaterhouseCoopers, JIIP, 'Assessment of Photovoltaics - Study Carried out on Behalf of the European Commission, DG RTD - Task A: Current State - Final Report', 2016.
[6] Trinomics, DNV-GL, PricewaterhouseCoopers, JIIP, 'Assessment of Photovoltaics - Study Carried out on Behalf of the European Commission, DG RTD - Task C: Historical Review of EU Decline - Final Report', 2016.
[7] Source: ibid
[8] Fraunhofer ISE, 'Photovoltaics Report 2018', 2018, https://www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/Photovoltaics-Report.pdf

3. Opportunities and threats of EU-China collaboration in the field of solar PV

Against the background described above, this section will now present and briefly discuss several opportunities and threats with regard to S&T cooperation with China in the field of solar PV, from an EU perspective.

3.1 Opportunity 1: Generally assumed benefits of international S&T cooperation

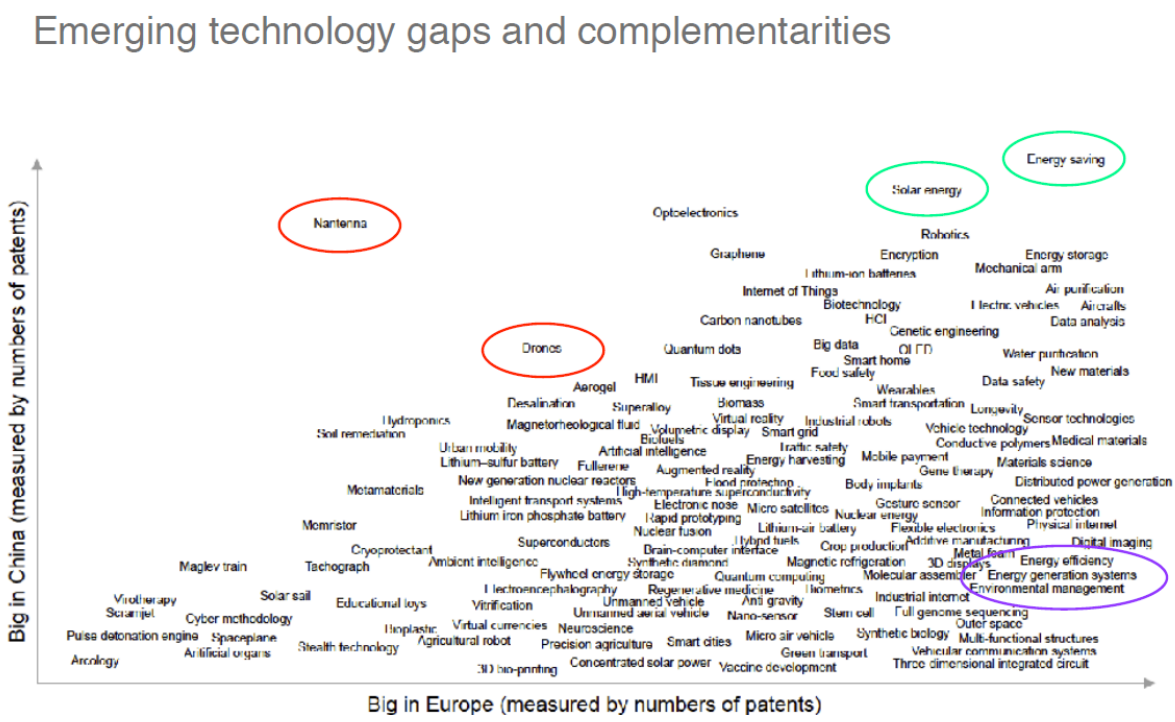
As already outlined above, the fostering of international cooperation in research and innovation has become quite prominent in recent communications and declarations of the European Commission[9]. One key document in this context has been the EC Communication ***Enhancing and focussing EU international cooperation in research and innovation: A strategic approach***[10]. It lists the "strengthening [of] the Union's excellence and attractiveness in research and innovation as well as its economic and industrial competitiveness" as one of the overall objectives of international cooperation. In relation to this, it also specifies the following specific objectives:

- Creating win-win situations and cooperating on the basis of mutual benefit;
- Accessing external sources of knowledge;
- Attracting talent and investment to the Union;
- Facilitating access to new and emerging markets;
- Agreeing on common practices for conducting research and exploiting the results.

We can agree that all these specific objectives also apply to the field of solar PV. As shown in the below diagram, solar energy is a field where both China and the EU are at the forefront of technological development. This provides a strong argument for the two sides to work together in order to jointly maintain and exploit this technological leadership. From this point of view, all the above-listed points can be seen as "opportunities" of collaboration.

[9] See also section 4 for more information on official EU documents concerning international S&T cooperation.
[10] European Commission, 'Enhancing and Focusing EU International Cooperation in Research and Innovation: A Strategic Approach', 2012.

Figure 2: Emerging technology gaps and complementarities (Source: DragonStar Plus project[11])



A more recent document which should be mentioned here is the vision paper ***Open Innovation, Open Science, Open to the World***[12]. As the title already clearly suggests, it makes the link between three concepts: conducting science in an open manner; developing new and innovative products in a co-creative way; fostering of international cooperation in research and innovation. In brief, it argues that, in order "to maximise their potential, the main components of the 'Open Innovation' and 'Open Science' policies should also be 'Open to the World'".[13] This perspective is in fact quite interesting as it puts the idea of open innovation from an (inter-)company level to an (inter-)country level. It adds to the general "opportunities" of collaboration.

3.2 Opportunity 2: Climate action and energy security as global challenges on which the world should work together

Both above-mentioned documents make also strong reference to the need for tackling global societal challenges through international collaboration. This idea is highly relevant to the field of solar PV as (together with other renewable energy sources), it can significantly help address at least two global challenges: climate change and energy security. In fact, this "opportunity" provides an even stronger imperative for cooperation than the previous one: While with regard to the idea that international R&I collaboration generally creates win-win situations, it is (at least implicitly) acknowledged that there

[11] DRAGON STAR Plus, 'China 2030 or the Way towards a Viable Cooperation with China - Presentation given at "Futures of a Complex World" Conference on 12 June 2017, Turku, Finland', 2017.

[12] European Commission, 'Open Innovation, Open Science, Open to the World'.

[13] In order to follow the reasoning, a brief explanation of the open innovation paradigm may be necessary: While the concept is constantly evolving, there are some key elements which are important. There is, first and foremost, the idea that it is beneficial for the innovation process if new product developments are not pursued "behind closed walls" of a company but in an open and co-creative process. The latter would involve in particular the users but also other relevant stakeholders along and across industry and sector-specific value chains. While it is acknowledged that there are of course risks in pursuing innovation processes in such an open way, it is argued that the opportunities outweigh the risks and if the individual company plays it smart, it will primarily see positive rather than negative effects of it. Closely linked to the concept of open innovation is that of open science. The latter essentially refers to the idea of involving citizens and all kinds of stakeholders as much as possible into the research process and sharing research results as early as possible.

are also certain risks, it is difficult to imagine what would be the "risk" of R&I collaboration with regard to climate action and energy security. One could in fact even go further and say that even if cooperation turned out to be a win-lose situation in economic terms for Europe (because China manages much faster and more cheaply to turn new discoveries and developments into new products, leading to market loss of European companies, for example), this would still be a good thing for climate action and energy security if looked at from a global perspective. As a matter of fact, from a truly international point of view, it does not really matter whether the best and best-sold products come from China or from Europe.

3.3 Threat 1: Solar PV as a mature technology in an extremely competitive market

As described in the background section above, solar PV can today be seen as a fully mature technology and the products are a commodity similar to mobile phones, TVs etc. The competition in this sector has been brutal and led to the destruction of the majority of the European industry, which was flourishing until 10 years ago. The statement that the technology is mature does not of course not mean that it cannot be improved. Further advances in efficiency and specialised applications (such as building- or product-integrated solar panels) can still significantly increase the attractiveness and rentability of PV products. But that is exactly where the risk is: If the basic technology is mature, Chinese producers are dominating the market and the only means for European producers to regain ground is by developing more efficient and/or more specialised technologies and applications, then there is a strong rationale for doing this alone, rather than together with the already dominating competitor. Otherwise, the risk is that the investments do simply not pay off, as Chinese companies might innovate their products as fast as (or even faster than) European companies, thus limiting the chances for European producers to regain market shares. Overall, the risk of European money (both public and private) being wasted is therefore quite substantial.

3.4 Threat 2: Specific issues with regard to R&I collaboration with China

In addition to the general risk of wasting money by developing new solutions jointly with already dominant competitors, there is a risk that specifically applies to China and which accentuates the problem. This particular risk concerns two interrelated issues: (1) Serious problems with regard to IPR protection and other legal issues and (2) a different type of industrial policy by the Chinese government which would not be possible in the EU and which is frequently judged as "unfair".

The first of these two points, the insufficient protection of IPR and different "culture" in this regard is a problem that is shared and expressed by a large number of companies doing business with Chinese partners and which is also very much acknowledged in various official documents[14] concerning EU-China S&T relations. It goes without saying that if there is already a neck-to-neck race with a competitor and the latter is generally known for a "lax" IPR enforcement, this does not exactly increase the case for collaboration. The risk of losing more than winning is simply becoming very high.

The second point, i.e. the different and often seen as "unfair" industrial policy is possibly somewhat less well known but certainly not less problematic. A report by Wübbeke et al. from the Mercator Institute for China Studies (merics), which analyses the "Made in China 2025" strategy, points very clearly to a number of interrelated issues in this regard. First of all, it states that "China's leadership systematically intervenes in domestic markets so as to benefit and facilitate the economic dominance of Chinese enterprises and to disadvantage foreign competitors"[15]. More specifically, it explains that

[14] The "Roadmaps for EU-China S&T cooperation" of 2014, 2016 and 2017 as well as he Joint Statement of the 2nd Innovation Cooperation Dialogue mention this very clearly.
[15] Wübbeke et al., 'Made in China 2025: The Making of a High-Tech Superpower and Consequences for Industrial Countries' (Mercator Institute for China Studies (merics), 2016). P. 7.

the Chinese government massively supports domestic high-tech companies while systematically setting barriers to market access and obstacles to business activities of foreign companies.[16] In other words, the principles of open markets and fair competition are not respected.

In addition to this policy aimed at import substitution, there is also a strong outward-looking aspect of the Chinese strategy. It consists in the equally heavily state-backed acquisition of international high-tech companies by Chinese investors. The above-mentioned report argues:

> "China pursues an outbound industrial policy with government capital and highly opaque investor networks to facilitate high-tech acquisitions abroad. This undermines the principles of fair competition: China's state-led economic system is exploiting the openness of market economies in Europe and the United States. Chinese high-tech investments need to be interpreted as building blocks of an overarching political programme. […] ***If successful, Made in China 2025 could accelerate the erosion of industrial countries' current technological leadership across industrial sectors.***"[17]

There is not much to be added to this passage, as it explains quite well the seriousness of the "threats" of collaborating with China in any high-tech sector.

[16] Ibid
[17] Ibid

4. The EU's framework for S&T cooperation with China

Following the analysis of opportunities and threats of EU-China collaboration in the field of solar PV, this section will analyse the EU's framework for S&T cooperation with China. For this, we will follow the distinction made by Luk van Langenhove between ***strategic tools***, ***operational tools*** and ***support tools***:

> "***Strategic tools*** for Science Diplomacy are policy documents that aim to give directions to what actors want to achieve and how to realise their policy goals. Here we are mainly talking about ***governmental communications*** that set out policies for Science Diplomacy. Such documents can contain general 'visions' of what a government aims to achieve or it can be more specific strategy declarations issued by the government or a governmental department, such as a Ministry of Science and Technology Policy or the Department of Foreign Affairs. […]
>
> ***Operational tools*** for Science Diplomacy are policy instruments used to put Science Diplomacy into practice. They involve the allocations of specific resources as well as mechanisms on how to use them. There exist many different operational tools to put Science Diplomacy in action. […]
>
> Finally, there are so-called ***support tools*** for Science Diplomacy that aim to promote or facilitate Science Diplomacy activities. These tools include […] training activities [….,] awareness building activities [… and] dialogue and consultation platforms."[18]

4.1 General framework of the EU's S&T cooperation with third countries

Before detailing the specific agreements for S&T cooperation between the EU and China, this first subsection will briefly describe the general set of tools which the EU typically uses for S&T cooperation with third countries.

4.1.1 Strategic tools

At the strategic level, cooperation with third countries in the field of research and technological development has been explicitly mentioned for the first time in the ***Single European Act*** of 1986[19], the first major "upgrade" to the European Communities since their foundation in the 1950's.

In 2008, the European Commission published its first strategic document entirely dedicated to international cooperation in science and technological development. The ***Strategic European Framework for International Sciences and Technology Cooperation***[20] specified two overall objectives of international S&T cooperation: (1) contributing to global sustainable development and (2) fostering Europe's scientific excellence as a basis for economic competitiveness. It lays out a number of principles for international S&T cooperation and suggests "orientations for actions to make the ERA more open to the world".

In 2012, the communication ***Enhancing and focusing EU international cooperation in research and innovation: a strategic approach***[21] gave a further push to international S&T cooperation. It specifies three overall objectives of cooperation with third countries: (1) strengthening the Union's excellence and attractiveness in research and innovation as well as its economic and industrial competitiveness, (2) tackling global societal challenges and (3) supporting the Union's external policies. With regard to

[18] Van Langenhove, Luk, 'Tools for an EU Science Diplomacy', 2017. Pp. 12-13.
[19] ECSC - EEC - EAEC, 'Single European Act', 1987. P. 338.
[20] European Commission, 'Strategic European Framework for International Sciences and Technology Cooperation (COM 588)', 2008.
[21] European Commission, 'Enhancing and Focusing EU International Cooperation in Research and Innovation: A Strategic Approach'.

the last point, the document explicitly introduces the concept of science diplomacy and of "mainstreaming research and innovation across other policies with a strong international dimension, such as trade, CFSP, environment and energy, and exploiting synergies with international cooperation in higher education proposed under Erasmus for All" and states that "development of the multi-annual roadmaps for international cooperation in research and innovation should, therefore, be closely coordinated with the general external country strategies and the external dimension of the Union's internal policies"[22].

In 2016, the RTD of the European Commission published the document ***Open Innovation, Open Science, Open to the World – a vision for Europe***. It does not represent a new policy initiative in itself but expresses DG RTD's visions and priorities for a future-oriented R&I policy. Amongst others, it puts strong emphasis on the opportunities and potentials of international cooperation in the field of STI.

4.1.2 Operational tools

In terms of operational tools, the European Union disposes of a number of instruments to support R&I collaboration. First and foremost, there is the European Framework Programme for Research and Innovation (FP), titled ***Horizon 2020*** (hereafter: H2020) in the current financial period 2014-2020. More concretely, it supports international S&T cooperation projects through the following types of actions:

- Funding for research and innovation projects in which the participation of third country entities is required or explicitly appreciated;
- Softer forms of cooperation such as networking between projects, clusters and/or programme managers;
- Joint initiatives involving the European Union and international partners (incl. coordinated calls, joint calls, contributions to funding programmes of third countries);
- Marie Skłodowska-Curie actions (MSCA) for international staff exchange;
- The European Research Council (ERC), which is open to researchers from third countries; and
- The Research Infrastructures activity, which has a specific focus on international cooperation.

It should definitely be noted here that any call in ***H2020*** is open to participation from virtually any country of the world. In cases where the participation of third country entities is not specifically required or requested, the evaluation would be made purely on the basis of the excellence of the proposal. The possibility to participate does however not automatically mean eligibility for funding. There are currently 16 so-called "Associated Countries" (all of them European or "nearby" countries) from which participants are automatically eligible for funding.[23] Furthermore, there are several dozens of lower- to middle-income countries which are also automatically eligible for funding without being associated to ***H2020*** in any way.

Apart from these general funding (sub-)instruments through which international cooperation can be supported, there are instruments which are implemented on a country-specific basis. These are mainly so-called multi-annual roadmaps and science and technology agreements with specific countries and regions. According to the European Commission, these STI agreements "constitute a framework and a privileged forum to identify common interests, priorities, policy dialogue, and the necessary tools for S&T collaboration".[24] At present, the EU has STI agreements with exactly 20 third countries, 18 of which are non-European countries.

---

[22] Ibid, section 5.4.1
[23] See full list at http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/3cpart/h2020-hi-list-ac_en.pdf
[24] https://ec.europa.eu/research/iscp/index.cfm?pg=countries, accessed on 16/02/2018

4.2 Specific agreements for S&T cooperation between the EU and China

4.2.1 Strategic tools

First diplomatic ties between the European Communities (EC) and the People's Republic of China had been established in 1975. Ten years later, in 1985, an agreement on trade and economic cooperation followed. In 1998, the first S&T agreement between both sides was signed. It was renewed in 2004 and 2009 and once again tacitly in 2014. In 2003, both sides upgraded their (general) diplomatic ties on the basis of a "Comprehensive Strategic Partnership". In 2008, Euratom and China signed an agreement for S&T cooperation specifically related to the "peaceful use of nuclear energy". An ***EU-China Urbanisation Partnership*** followed in 2012.[25,26]

Under the EU's so-called 7th Framework Programme for Research and Innovation (FP7) which ran from 2007 to 2013, China was one of the International Cooperation Partner Countries (ICPC) which were automatically eligible for funding. This changed with the successor programme ***H2020***, which started in 2014. The same change however also applied to a number of other countries such as Brazil, India, Mexico and Russia, for example. While there was most obviously a decision to exclude this "category" of countries[27], it was not a decision specifically concerning China.

In 2013, in the context of the 16th EU-China Summit, both sides jointly adopted an ***EU-China 2020 Strategic Agenda for Cooperation*** and held the ***1st EU-China Innovation Cooperation Dialogue (ICD)***. According to the European Commission, "the ICD has the ambition of raising the level and intensity of research and innovation relations with China by providing a forum for discussing respective innovation policies and systems, addressing framework conditions and launching new joint R&I initiatives"[28]. The 2nd EU-China ICD was held two years later, in 2015. There, the two sides agreed to ensure reciprocal access to respective research and innovation funding programmes as well as new co-funding mechanisms.[29] More concretely, there is one general co-funding mechanism with the Chinese Ministry of Science and Technology (MOST) as well as several more specific ones, such as with the National Natural Science Foundation of China (NSFC) and the Chinese Ministry of Industry and Information Technology (MIIT).[30]

The 3rd EU-China ICD was held in June 2017 in Brussels and was considered as a further important step in deepening the relations between both sides. In this context, two documents were signed:

(1) a joint statement concerning a package of flagship initiatives in the following areas:
- (a) Food, Agriculture and Bioeconomy (FAB);
- (b) Environment, Climate & Sustainable Urbanisation;
- (c) Aviation;
- (d) Biotechnologies and Biomaterials; and
- (e) Surface Transport;

(2) a framework research arrangement between the European Commission's Joint Research Centre (JRC) and the Chinese Academy of Sciences.[31]

---

[25] '2nd EU-China Innovation Cooperation Dialogue - Joint Statement', 2015.
[26] European Commission, DG RTD, 'Roadmap for EU-China S&T Cooperation (2017)', 2017.
[27] It is safe to assume that this decision was linked to the significant economic development that all these countries had undergone during the preceding years.
[28] https://ec.europa.eu/research/iscp/index.cfm?amp;pg=china, accessed on 16/02/2018.
[29] European Commission, 'Open Innovation, Open Science, Open to the World'. P. 69.
[30] http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020_localsupp_china_en.pdf, accessed on 20/02/2018.
[31] https://ec.europa.eu/research/iscp/index.cfm?amp;pg=china, accessed on 16/02/2018.

4.2.2 Operational tools

As already mentioned before, China was one of the International Cooperation Partner Countries (ICPC) which were automatically eligible for funding under FP7. It lost that status with the change to the successor programme ***H2020***. At the same time, however, the European Commission has started encouraging cooperation with Chinese partners on a number of specific topics. This happens predominantly in the context of certain priority areas, such as the various flagship initiatives recently agreed upon. For these, Chinese participants can make use of the co-funding mechanism that has been negotiated with the Chinese side. The ***2017 Roadmap for EU-China S&T cooperation*** lists a significant number of ***H2020*** calls dedicated to cooperation with China, specifically in the various flagship initiatives:

- ***Flagship initiative "Food, Agriculture and Biotechnologies (FAB)"***
  Launched in 2014, the initiative has so far resulted in 12 ***H2020*** topics dedicated to cooperation with China, with a total EU budget of 94 million EUR. This in turn has led to 13 joint projects involving 63 Chinese partner organisations. Four more topics are included the work programme 2018-2020.

- ***Flagship initiative "Environment and Sustainable Urbanisation"***
  This initiative has resulted in 8 topics under ***H2020*** so far and two more are currently included in the work programme 2018-2020.

- ***Flagship initiative "Surface Transport"***
  One concrete topic is listed in the work programme 2018-2020.

- ***Flagship initiative "Biotechnologies"***
  Three concrete topics are listed in the work programme 2018-2020.

- ***Flagship initiative "Aviation"***
  One concrete topic is listed in the work programme 2018-2020.

In addition to these flagship initiatives, the work programme 2018-2020 also lists 16 topics in other areas which are targeting specifically the participation of Chinese partners. These are in the following fields: Energy, ICT, Climate, Health, Space, Research Infrastructures, Other Biotechnologies and Other Transport.[32] Looking at all work programmes of ***H2020***, we see that there has been a total of 70 topics specifically encouraging collaboration with China. In comparison to other countries, this number is only topped by topics encouraging collaboration with the US, for which there were 101 topics (see also Table 1 on page 19).

Furthermore, there are concrete cooperation activities going on between the EC's Joint Research Centre and several Chinese universities and government bodies. The latest was signed with the Chinese Academy of Sciences and the Chinese Academy of Environment Sciences. The following areas are mentioned as priority areas: 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, water. Cooperation in the following areas will be "reinforced and extended": climate, environmental pollution, smart grids, innovation ecosystems and territorial aspects of innovation, including smart specialisation.[33]

[32] http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020_localsupp_china_en.pdf, accessed on 20/02/2018.
[33] European Commission, DG RTD, 'Roadmap for EU-China S&T Cooperation (2017)'.

Last but not least, there are of course grants provided to individual researchers through the Marie Skłodowska-Curie actions (MSCA) and the ERC, which are however not part of any country-specific strategy.

4.2.3 Overall assessment

Overall, it can be said that China is without doubt one of the most important S&T cooperation partners of the EU. This manifests itself, amongst others, in the fact that there is an "Innovation Cooperation Dialogue", rather than just a science & technology agreement between both sides. Also, the co-funding mechanism that has been agreed with the Chinese Ministry of Science and Technology as well as the various above-mentioned flagship initiatives show clearly that both sides want to have a "privileged partnership" with each other. Furthermore, in terms of concrete implementation, China is number two in terms of ***H2020*** topics explicitly encouraging collaboration with third countries, only topped by the US. All of these aspects are clearly an expression of the strategic importance that both sides attach to each other.

5. Analysis of the EU's reaction to the solar PV issue

As pointed out in sections 3.1 and 3.2, there are a number of opportunities lying in EU-China S&T cooperation in the field of solar PV. First of all, as both sides are technological leaders in the field, R&I collaboration could create a win-win situation in the sense that both sides continue to stay at the technological forefront. Second, the fact that the technology presents a solution to at least two so-called global challenges provides an additional rationale to further improve it through international collaboration. At the same time, as also pointed out in sections 3.3 and 3.4, there are doubtlessly certain risks linked to collaboration with China in this particular field. These is, first of all, the fact that solar PV is a heavily commoditised market in which Europe has essentially already lost the battle. The development of more efficient and/or niche applications would be the only realistic way for European producers to regain some of the lost ground. From this point of view, it seems more sensible to do this alone rather than getting the already dominating competitor involved. This point needs to be even more emphasised in view of the fact that irrespective of the technology field, the Chinese side (in terms of individual companies and in terms of government policies supporting these) is often seen as "playing by somewhat different rules".

The objective of this section is to analyse to what extent this tension is reflected in the EU's science diplomacy vis-à-vis China. In other words, the underlying analytical question is: ***In a sector which is as competitive as that of solar PV, does the EU stick to its proclaimed principles of "open innovation, open science, open to the world" and of "global challenges need global solutions"? Or do other forces, which are in conflict with these principles, prevail?***

For this analysis, we will make use of several types of sources: (1) official documents released by the European Commission, more specifically DG RTD, as well as agreements and joint statements of both sides, (2) quantitative data concerning concrete call topics and other actions encouraging collaboration with China, and (3) interviews conducted with relevant EC officials. While the first type of source will focus on what has previously been defined as "strategic tools", the second type will primarily relate to "operational tools". The third type of source will relate to both levels and help (a) better interpret information obtained through the other two types of sources and (b) access additional information which could not be accessed on the basis of the written sources.

5.1 Analysis of official documents and agreements

In view of the importance that the solar PV technology plays for (a) the European industry, (b) the Chinese industry, and (c) the solution of the global challenges of climate change and energy security, it would normally be very plausible to expect some references to it in official documents or agreements concerning the S&T cooperation between both sides. In fact, even a relevant flagship initiative such as those mentioned in section 4.2.2 would not seem unlikely. After all, these flagship initiatives have been defined precisely on the basis of the importance of the respective industry and/ or the related "challenge" to both sides.

However, without going through all the documents that have been screened, we can state here that not a single reference to solar PV as a (potential field of collaboration) could be found in any relevant document.[34, 35] This is quite remarkable in view of the above points and of the fact that energy and clean energy in particular is in fact prominently identified as a field of collaboration, such as the

[34] By "relevant documents" we refer to all those listed in the relevant part of the bibliography.

[35] To be sure, there are of course a number of documents by DG TRADE which relate to the trade conflict between both sides in the solar PV field. While these are doubtlessly very relevant for understanding the background, they will not help very much answer the underlying analytical question which has been formulated in the introduction paragraph to section 5. In order to keep our analysis sharp and focused, this section will therefore not consider the documents relating to the trade conflict but focus on those published by DG RTD.

following: “China is a strategic partner for the EU in energy research and innovation (R&I) considering the size of the its market, its commitment to increase RD&D spending for clean energy as well as its commitment to the Paris Agreement”, as stated in the 2017 Roadmap for EU-China S&T Cooperation.

The impression is in fact quite strong that solar PV has been deliberately left out: While a number of references to specific renewable or “clean” energies can be found, these are all different ones, such as: concentrated solar power; carbon capture and storage technologies; hydrogen safety[36, 37, 38, 39]. It seems particularly remarkable that concentrated solar power is identified as a field for collaboration. This technology can be seen as a competitor of solar PV, as it uses the same energy source but an entirely different technology to convert it into electricity.

To be sure, it should be stated here that also several other important renewable energy technologies are not mentioned in any of the documents. This applies notably to wind energy, for example. On the one hand, this might be seen as an argument against the hypothesis that it is specifically and deliberately solar PV which has been excluded. On the other hand, it should also be borne in mind that China has not only reached global dominance with regard to solar PV but has also become the most important competitor in wind (and other renewable) energy technologies[40]. Hence, the reasons why wind (and other renewable) energy technologies are not mentioned either in any of these documents might just be the same as those explaining why there are no references to solar PV.

5.2 Analysis of Horizon 2020 topics

The impression that R&I collaboration with China in the field of solar PV is deliberately not supported is confirmed when looking at the concrete H2020 calls. For this, we have analysed all H2020 calls and topics encouraging collaboration with China, over the entire programming period from 2014 to 2020. The findings are quite clear and speak for themselves:

Out of a total of 70 topics explicitly encouraging collaboration with China, thereof 48 under the ***Societal Challenge*** pillar[41] of H2020, ***not a single one referred directly to solar PV***. Once again, it should be conceded that not only solar PV but also the entire field of renewable and/ or clean energy technologies seem significantly underrepresented among the H2020 topics explicitly encouraging collaboration with China. Overall, during the entire duration of H2020, there were only 4 topics related to so-called ***Societal Challenge 3 – Secure, Clean and Efficient*** (hereafter SC3) energy which were explicitly encouraging cooperation with China: Two of them (LCE-18-2014 and LCE-18-2015) were ERA-NETs “Supporting Joint Actions on demonstration and validation of innovative energy solutions” and two others (LCE-29-2017 and LC-SC3-NZE-5-2019-2020) were related to carbon capture utilisation and storage (CCUS). The latter two do of course not even relate to renewable but only to “clean” energy production. Once again, this shows that the European Commission does not only leave out solar PV from the list of topics in which cooperation with China is explicitly encouraged, but that the field of renewable energies as a whole seems to be very low on the “wish list” for collaboration with China. As argued in section 5.1, this does not necessarily weaken the impression that there is a conscious decision against specific support for R&I collaboration in the field of solar PV. Instead, the reasons to

[36] ‘2nd EU-China Innovation Cooperation Dialogue - Joint Statement’.
[37] European Commission, DG RTD, ‘Roadmap for EU-China S&T Cooperation (2014)’, 2014.
[38] European Commission, DG RTD, ‘Roadmap for EU-China S&T Cooperation (2016)’, 2016.
[39] European Commission, DG RTD, ‘Roadmap for EU-China S&T Cooperation (2017)’.
[40] Institute for Energy Economics and Financial Analysis (IEEFA), ‘China 2017 Review: World’s Second-Biggest Economy Continues to Drive Global Trends in Energy Investment’, 2018.
[41] Horizon 2020 is largely grouped into the following three “pillars”: (1) Excellent Science; (2) Industrial Leadership; and (3) Societal Challenges. Under each of these pillars, there are then a number of areas called “Work Programme Parts”. Each concrete call for proposals is then linked one of these Work Programme Parts and usually consists again of several specific topics.

also exclude other renewable energy technologies such as wind might simply be quite similar and directly related.

The almost negligible[42] number of renewable energy-related topics explicitly encouraging collaboration with China becomes even more remarkable in view of the fact that the 48 out of the 70 China-related topics are under the ***Societal Challenges*** pillar. In other words, while the European Commission sets a clear focus in its cooperation efforts on those related societal challenges, there seems to be a clear prioritisation of certain "challenges" over others. This is in contrast with the overall distribution of all calls within the ***Societal Challenge*** pillar, where the share of calls related to SC3 represents 20 out of 128. This makes a share of 15.6% of all SC3 calls over all ***Societal Challenge***-related calls, as opposed to a share of 8.3% if we only look at those topics that are explicitly encouraging collaboration with China.[43]

A comparison with the number of topics encouraging collaboration with other countries and the share of SC3-related topics within them is of interest here. Table 1 shows the distribution of topics encouraging cooperation with the EU's 8 most important S&T cooperation partners. We can see that also for other countries, the share of SC3-related topics within the ***Societal Challenge*** pillar is quite low:

- For Brazil, only 1 out of 25 ***Societal Challenge***-related topics relates to SC3 (corresponding to 4%) – the topic related to biofuels;
- for Japan, the rate is 0 out of 29 topics (corresponding to 0%);
- for Russia, the rate is 0 out of 10 topics (corresponding to 0%);
- for the US, it is 5 out of 65% (7.6%) – the topics related to CCS and shale gas exploration.

For the following countries, the rate was significantly higher:

- For Canada, the rate is 4 out of 33 topics (corresponding to 12.1%) – the topics related to CCS and shale gas exploration;
- for India, the rate is 3 out of 17 topics (corresponding to 17.6%) – the topics related to CCS/CCUS and energy systems;
- for South Korea, the rate is 8 out of 17 topics (47%) – the topics related to CCS/CCUS, local heating and cooling solutions, social sciences and humanities aspects of the clean-energy transition and energy systems.

What is remarkable here is the fact that out of a total of 421 topics explicitly encouraging collaboration with one of the EU's eight most important S&T cooperation partners, thereof 244 under the ***Societal Challenge*** pillar of H2020, not a single one referred directly to solar PV. In fact, the majority of the topics also targeting other countries concerned CCS/CCUS, which is not a renewable energy. It is astonishing that, apart from the one biofuels-related topic encouraging collaboration with Brazil, not a single topic related directly to the technical development "real" renewable energy technologies.

The fact that technological development in solar PV but also in other renewable energies was virtually completely "off the list" of topics encouraging collaboration with the EU's eight most important S&T cooperation partners deserves an analysis in itself. This would, however, have to be done in a separate study, as the whole research design of this study was laid out with a clear focus on China. For the present study, it should therefore suffice to state that the "discrimination" of renewable energy technologies does not seem to be specific to the topics encouraging cooperation with China.

---

[42] Considering that out of the four identified topics, two are for ERA-NETs and two only refer to "clean" but not to "renewable" energy technologies.

[43] The comparison is not 100% "clean" in the sense that one of the figures relates to ***calls***, whereas the other relates to ***topics***. But in order to have an approximate idea, it should suffice at this point.

Table 1: H2020 topics explicitly encouraging collaboration with the EU's eight most important S&T partners

	China		Brazil		Canada		India		Japan		South Korea		Russia		USA		ALL	
	# topics	Subtotal	# topics	Subtotal	# topics	Subtotal	# topics	Subtotal	# topics	Subtotal	# topics	Subtotal	# topics	Subtotal	# topics	Subtotal	# topics	Subtotal
Excellent Science																		
European Research Infrastructures	3		4		5		3		4		2		5		6		32	
Future and Emerging Technologies (FET)			1										1				2	
Subtotal		***3***		***5***		***5***		***3***		***4***		***2***		***6***		***6***		***34***
Industrial Leadership																		
ICT	6		5		1		1		14		13				11		51	
Nanotechnologies	9		10		10				11		12				16		68	
Advanced materials									2								2	
Biotechnology	2																2	
Advanced manufacturing and processing																		
Space	1		1		1		2		1		3				2		11	
Subtotal		***18***		***16***		***12***		***3***		***28***		***28***				***29***		***134***
Societal Challenges																		
SC1 - Health, demographic change and wellbeing	4		5		3		1		3		1		1		4		22	
SC2 - Food security, sustainable agriculture and forestry, marine an	15		5		13		2		3		1		1		13		53	
SC3 - Secure, clean and efficient energy	4		1		4		3				8				5		25	
SC4 - Smart, green and integrated transport	10		7		8		4		14		5		5		26		79	
SC5 - Climate action, environment, resource efficiency and raw mat	8		3		4		5		4		1		2		6		33	
SC6 - Europe in a changing world - inclusive, innovative and reflecti	4		3		1		2		1				1		3		15	
SC7 - Secure societies - protecting freedom and security of Europe a									3		1				7		11	
Cross-cutting (mostly sustainable urbanisation)	3		1						1						1		6	
Subtotal		***48***		***25***		***33***		***17***		***29***		***17***		***10***		***65***		***244***
Science with and for Society	1		1		1		1		1				1		1		7	
Subtotal		***1***		**1**		**1**		***1***		***1***				***1***		***1***		***7***
EIT			1				1										2	
Subtotal				**1**				***1***										***2***
TOTAL		**70**		**48**		**51**		**25**		**62**		**47**		**17**		**101**		**421**

5.3 Analysis of interviews conducted with relevant EC officials

In the following subsection, we will present and analyse the key findings of the interviews which have been conducted with a number of European Commission officials that are connected in one way or another to the topic of this study. The interviews were semi-structured and focussed on the following four key aspects: (1) views on the tension between the concepts of science diplomacy on the one hand innovation (policy) on the other; (2) general views on the science and technology relations with China; (3) statements concerning the R&I collaboration with China specifically in the field of solar PV; (4) the role of the ***Mission Innovation*** initiative.

We conducted interviews with five officials from DG RTD and the EEAS, more specifically of the following units:

1) Directorate-General for Research and Innovation (DG RTD), Directorate C – International Cooperation, Unit C.1 – Strategy, EFTA and enlargement countries, Russia Asia and Pacific
2) Directorate-General for Research and Innovation (DG RTD), Directorate G – Energy, Unit G.1 – Strategy (hosting also the ***Mission Innovation*** secretariat)
3) Directorate-General for Research and Innovation (DG RTD), Directorate G – Energy, Unit G.3 – Renewable energy sources
4) European External Action Service (EEAS), Directorate ASIAPAC – Asia and Pacific, Unit 4 – China, Hong Kong, Macao, Taiwan, Mongolia
5) European External Action Service (EEAS), Delegation to the People's Republic of China, Science, Technology and Environment Section

5.3.1 Views on the tension between the concepts of science diplomacy and innovation in general

All partners who were asked about their views concerning the tension between the competition-oriented dimension of innovation policies on the one hand and the cooperation-oriented dimension of science diplomacy on the other clearly confirmed that they also see this conflict. At the same time, we learned that there are very diverging views on this question within DG RTD. Of course, there is also the strong view that cooperation in fields where both sides are strong and advanced is a sine-qua-non condition for competitiveness. One interviewee stressed the fact that this question depends very much on the specific partner country. As long as there is a level-playing field between both sides, cooperation also in highly competitive fields is less problematic. As stated by the sane interviewee, "the case of China, however, is a bit trickier. Here, the state enters into the game with very clearly and strategically selected priorities. R&I policy actually becomes an instrument of industrial policy". The interviewee continued to say that they saw the term "innovation diplomacy" as being of limited use. Whereas "science" was a public good, "'innovation' is something that you are going to put on the market, so it is either 'you' or 'I' who is going to profit from it".

Another interviewee argued that they saw the whole concept of science diplomacy as outdated. The original idea of science diplomacy was to create openings in difficult contexts, such as in the Cold War context. The situation today was a very different one, where between most countries of the world, there were established links and exchange of people, economies etc. "What we are working on today is new cutting-edge disruptive technologies and we are dealing with issues regarding market access and competitiveness; in this context, the concept is not particularly useful." The same interviewee went on to make the following statement: "As one of very few having worked both in the context of science policy and in the diplomatic context, I can say that diplomats don't understand scientists and scientists do not understand diplomats." Considering all this, this interviewee concluded that the concept of science diplomacy might still make sense in basic research, adding that the ERC was a good example of that, but not much beyond that.

Other interviewees were less pronounced about these points, but generally arguing into the same direction.

5.3.2 Views on S&T relations with China in general

The views on the S&T relations with China were more diverse. One interviewee was quite positive, pointing out that the advancement of S&T relations with China was one of the most positive aspects of the EU-China summit in June 2017. Several others did not directly disagree with this view, but stressed that the field of energy research, for example, where both sides strongly compete, was de facto excluded from any agreements on further enhanced cooperation made at this summit. This is of high relevance to the subject of this case study, of course.

Several of the interviewees referred to difficulties in R&I collaboration with China, such as IPR infringements and/or lack of enforcement as well as a lack of "reciprocity" in access to research programmes etc.

5.3.3 Statements concerning S&T cooperation in the field of solar PV with China

Essentially all our interviewees clearly confirmed that enhanced S&T cooperation with China in the field of solar PV was stopped because of the developments and the situation as described in sections 2, 3.3 and 3.4. It was even stated repeatedly by one interviewee that the solar PV case has been a "turning point", which "has influenced a lot what we do with China in energy research in general today". The same interviewee stated that there was a "fear" that a similar development may take place in wind energy.

We learned that the last solar PV-related project with a Chinese partner, which resulted from an FP7 call topic explicitly encouraging collaboration with China, was the "SILICON_LIGHT" project, which ran from January 2010 to December 2012. The project was based on call FP7-ENERGY-2009-1 which in turn was published in August 2008. For our analysis, it is very important to note that at that point of time, the developments as described in section 2 were only in their very beginning and the scale and significance of the subsequent crisis were not yet visible at all. This had also been the only topic under FP7 that had encouraged collaboration with a Chinese partner.

Several interviewees stressed the fact that the EC's policy is not to explicitly exclude this topic from cooperation with China, but simply to focus on other areas. If a proposal is submitted with Chinese partners on board, it will always be evaluated based on its excellence. As far as the funding is concerned, it is up to the Chinese Ministry for Science and Technology MOST to decide about co-funding. While it is understandable that certain EC representatives want to stress this point, it does not change the overall picture.

5.3.4 The role of Mission Innovation

Several of the DG RTD representatives stated that R&I collaboration with China in clean energy was specifically supported through ***Mission Innovation*** (MI). The latter is an initiative of 22 countries and the European Union that "are taking action to double their public clear energy R&D investment over five years. In addition, MI members encourage collaboration among partner countries, share information, and coordinate with businesses and investors. Mission Innovation is complemented by private sector-led investments of extraordinary levels of private capital in clean energy, focusing on early-stage innovations."[44]

The extent to which this initiative really encourages cooperation between the members is however quite varied, as we learned from an official in charge of certain MI-related activities at DG RTD.

[44] http://mission-innovation.net, accessed on 28/02/2018.

Essentially, there are three possibilities for cooperation. The first and strongest one is concrete coordinated calls. This possibility has been used for a coordinated call with Mexico on geothermal energy as well as for a coordinated call with Brazil on biofuels (also referred to in section 5.2). However, this option is administratively quite difficult, and several MI partners are basically not open to it, precisely because of the competitive dimension. The second possibility is calls that target one specific country. In this case, there is essentially a unilateral call with money provided by one side. The eligibility for funding of the potential partner(s) from the target country depend on the general eligibility provisions for partners from that country. The third possibility is "twinning", where each side does essentially their own projects and in the end, they share experiences.

Overall, it was admitted that the success in terms of encouraging joint calls etc. was limited. The initiative served more to exchange experiences and best practices. This worked reasonably well with partners such as the US and Canada, but much less with China, for example. As regards the general situation with regard to China in this context, it was stated that the country was not a very transparent partner, in the sense that there is not very much sharing of experiences nor of interests. This however was necessary to create trust.

We also learned that one key reason for the fact that energy in general is quite underrepresented among the topics which are explicitly encouraging cooperation with third countries is the fact that this is "invisibly blocked" by the EU Member States. The interviewee was quite clear in pointing out that energy technologies are mostly a commodity, closely linked to industrial policy. Member States try to "cater for" their own industry and are therefore not particularly open for cooperation in this field. This was very different, for example, in the field of climate change, where cooperation is very strong and where Member States have given a sort of "mandate" to the EC.

6. Discussion, conclusions and outlook for further research

6.1 Discussion and conclusions

Following the various analyses made in the previous chapters, we are now coming back to the question formulated in the introduction, as to whether the strong competition between Europe and China in the field of solar PV is reflected in the science diplomacy between both countries.

There are several ways of looking at this question. The first perspective would be to look at the impact that the particular case of solar PV has on the overall S&T relations between the EU and China. Various parts of the case study have shown that China is one of the most privileged S&T cooperation partners of the EU. A first S&T agreement had been signed in 1998 and has been renewed three times since then. Since 2013, this partnership has been upgraded to an ***Innovation Cooperation Dialogue***. According to several interviewees this dialogue is generally seen as very successful. Also, when looking at "pure" facts and figures, it is quite clear that China is and remains one of the most important partners in terms of S&T cooperation. In terms of the number of topics explicitly encouraging cooperation with third countries, China is number two with 70 topics during the whole programme period of H2020, after the US (with 101 topics) and ahead of Japan (with 62 topics). On the basis of these data, it would be difficult to argue that the solar PV case had had a significant deteriorating impact on the overall S&T relations between the EU and China.

The second perspective would be much narrower and focus on the question of how S&T cooperation specifically in the field of solar PV is affected by the fierce competition between both sides. This question can be answered in an extremely clear way: There is simply no specific encouragement for collaboration at all in this field and there is no doubt that this is a direct result of the tough competition in the field. This finding is evidenced both by clear quantitative and by unambiguous qualitative information. The quantitative facts are, for example, that the last FP topic which explicitly encouraged collaboration with China in the field of solar PV was drafted and published before the "fall" of the European solar PV industry. Since then, i.e. over a period of more than 10 years now, there has not been a single topic directly encouraging R&I collaboration with China in this field. Also, the statements of our interviewees were unequivocal in this regard. With only minor nuances, all of them clearly said that there is no intention to specifically encourage collaboration with China in the field of solar PV. It was also stated repeatedly that this was a direct consequence of the experience with solar PV.

As a result of our research, we can suggest a third, intermediate perspective here. It concerns the impact that the solar PV "experience" has on S&T relations in the wider renewable energy domain. As one interviewee said: "The solar PV case has been a turning point, which has influenced a lot what we do with China in energy research in general today." The same person continued to say that there was definitely a fear that a similar development might take place in the field of wind energy. We have seen very clear evidence that indeed, the number of topics explicitly encouraging collaboration with China in other renewable energy fields such as wind was just as low as the number of topics in solar PV, i.e. "0". Hence, while the strong competition in one technology does not prevent the two sides from having overall very good and intensive relations, this shows that the solar PV case cannot be seen in isolation but has clear effects on S&T cooperation in the wider renewable energy domain.

Which lessons and conclusions can be drawn from all of this? We would argue that there is one main conclusion, which is the fact that it seems to make little sense to transfer the concept of "science diplomacy" with its cooperation-oriented win-win philosophy to the realm of innovation with its competition-oriented, close-to-market dimension. The case study has shown quite clearly that, where commercial interests come into play and interfere with the idealistic idea of "open innovation, open science, open to the world", the former clearly prevails over the latter. Seemingly, this is even the case for a technology that has a strong potential to help address global challenges, which would provide another rationale for international collaboration.

One may of course argue that the case chosen for this study is an extreme one, with a sector that is experiencing particularly "cruel" competition and with a country which is known to be not the fairest competitor anyway. While both things are true, the two following things should also be said. First, it was the very idea of this case study to pick precisely such case, as we deemed that this would obviously be the best way to also have clear results. Most other cases will be less extreme and the situation therefore less straight-forward, but we would argue that this would not change the underlying dynamics. Second, as the data and analysis in section 5.2 have shown, the hesitance to engage in S&T cooperation in the field of renewable energies does clearly not seem to be restricted to cooperation with China. In the entire programme period of ***H2020***, there has in fact been only one single call that encouraged cooperation with a third country in real technological development in "real" renewable energies. Also, the statements from many of the interviewees were quite clear in general in this regard, such as the following: "There must be a win-win situation for both sides. If this is not the case for the EU side, then there is not really an interest. This is the guiding principle."

6.2 Outlook for further research

Following the above conclusion, we would like to suggest specific fields and contexts in which the concept of "innovation diplomacy" may still make sense. One such context is quite obvious. It would be in areas where there are much less commercial implications, i.e. where there is not an entire industry including thousands of jobs depending on it. One may think of certain areas related to societal challenges where the development of less commercially oriented solutions is supported. Climate adaptation would be an area in which such topics could be conceived of, for example.

Another context would the that of development cooperation. Here, the approach would actually be quite a different one. Rather than trying to get the most for one's own industry out of it, the idea would be to actually support the development of an industry in the target country. As opposed to classical development cooperation where money and/ or ideas are transferred to the target country, innovation diplomacy could consist in the co-development of solutions that are particularly suitable to respective development partner country. These could be based on existing concepts or solutions which however need or would benefit from tailoring to the specific context of the development partner country. This could result in a way of development cooperation where local partners are not simply "recipients" but real "development partners", which in turn may provide a much more sustainable basis for development, building on local products and local business models, owned and further maintained by local partners.

This is not to claim that such support activities for innovation in the context of development cooperation do not yet exist. The key point might actually be in the framing and highlighting of the importance of such activities. A recent "Evaluation of the EU Support to Research and Innovation for Development in Partner Countries (2007-2013)", for example, has stressed exactly this point:

> "Support to R&I was therefore a major theme of DEVCO work, yet one that is hidden, not recognised and poorly understood. Given the importance of scientific knowledge and technology for economic development and the rapid pace of change and innovation, this high level of funding is not surprising but what is striking is its low profile."[45]

Other recent publications by DG RTD, the OECD and UNDP have hinted into similar direction.[46,47,48] Against this background, we suggest to further analyse the potential of innovation in the context of development cooperation.

[45] Particip, 'Evaluation of the EU Support to Research and Innovation for Development in Partner Countries (2007-2013)', 2016.
[46] European Commission, DG RTD, 'Science and Innovation for Development', 2016.
[47] OECD, 'Innovation for Development', 2012.
[48] UNDP, 'Spark, Scale, Sustain', 2017.

7. Bibliography

'2nd EU-China Innovation Cooperation Dialogue - Joint Statement', 2015.

DRAGON STAR Plus. 'China 2030 or the Way towards a Viable Cooperation with China - Presentation given at "Futures of a Complex World" Conference on 12 June 2017, Turku, Finland', 2017.

ECSC - EEC - EAEC. 'Single European Act', 1987.

European Commission. 'Enhancing and Focusing EU International Cooperation in Research and Innovation: A Strategic Approach', 2012.

———. 'Open Innovation, Open Science, Open to the World: A Vision for Europe', 2016.

———. 'Strategic European Framework for International Sciences and Technology Cooperation (COM 588)', 2008.

European Commission, DG RTD. 'Roadmap for EU-China S&T Cooperation (2014)', 2014.

———. 'Roadmap for EU-China S&T Cooperation (2016)', 2016.

———. 'Roadmap for EU-China S&T Cooperation (2017)', 2017.

———. 'Science and Innovation for Development', 2016.

Fraunhofer ISE. 'Photovoltaics Report 2018', 2018. https://www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/Photovoltaics-Report.pdf.

Institute for Energy Economics and Financial Analysis (IEEFA). 'China 2017 Review: World's Second-Biggest Economy Continues to Drive Global Trends in Energy Investment', 2018.

OECD. 'Innovation for Development', 2012.

Particip. 'Evaluation of the EU Support to Research and Innovation for Development in Partner Countries (2007-2013)', 2016.

Trinomics, DNV-GL, PricewaterhouseCoopers, JIIP. 'Assessment of Photovoltaics - Study Carried out on Behalf of the European Commission, DG RTD - Task A: Current State - Final Report', 2016.

———. 'Assessment of Photovoltaics - Study Carried out on Behalf of the European Commission, DG RTD - Task C: Historical Review of EU Decline - Final Report', 2016.

UNDP. 'Spark, Scale, Sustain', 2017.

Van Langenhove, Luk. 'Tools for an EU Science Diplomacy', 2017.

Wübbeke et al. 'Made in China 2025: The Making of a High-Tech Superpower and Consequences for Industrial Countries'. Mercator Institute for China Studies (merics), 2016.

About the author

Daniel has degrees in European Studies (B.A. Honours, Trinity College Dublin, 2005) and International Relations (M.A., King's College London, 2006). He has also done extensive postgraduate coursework on Evaluation of Public Policies (Manchester Institute of Innovation Research; Université Catholique de Louvain). Daniel started working with the Joint Institute for Innovation Policy (JIIP) in 2010 and has been involved in the establishment and setting up of the institute almost from the very beginning. Having focused on studies and projects for the European Commission primarily in the field of research and innovation policy since then, his involvement in the EL-CSID project is an excellent opportunity to combine his original educational background in International Relations with his expertise in the analysis of science, research and innovation policies gained over the last eight years.

The EL-CSID project
is coordinated
by the
Institute for European Studies (IES)
www.el-csid.eu

Institute for European Studies
Pleinlaan 5
B-1050 Brussel
T: +32 2 614 80 01
E: ies@vub.ac.be
www.ies.be

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 693799.