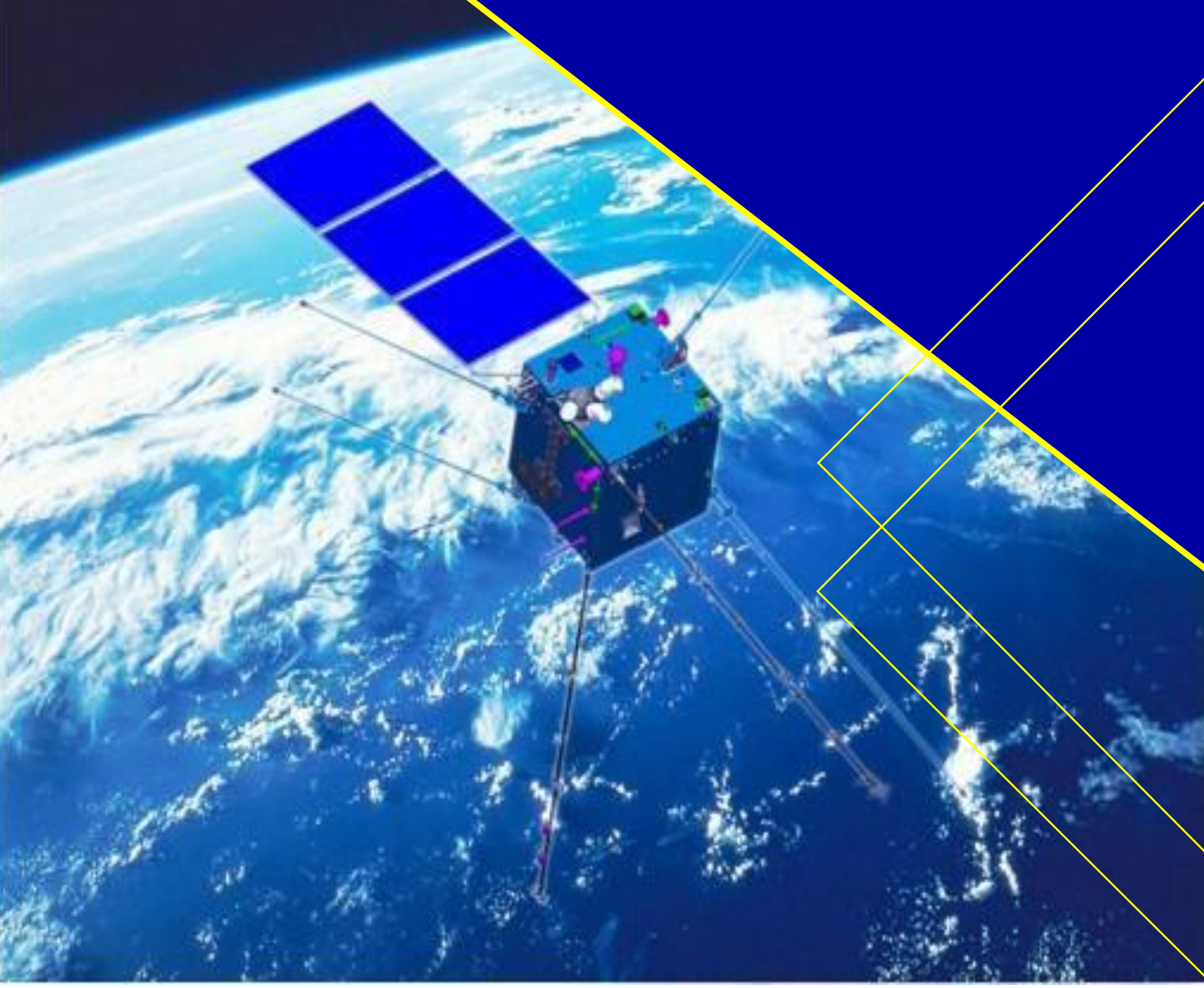

A CASE OF GEO-INNOVATION IN THE 21ST CENTURY:

Italy's Science, Technology and Innovation Partnership with China

CDA Systemic Country Insights (SCI) Publication Series, Edition 1/2021

China Data Analysis & Research Hub

EX SAPIENTIA LUX

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This work is a product of a team of CDA related scholars from Italy and China with external contributions led by Prof. Francesca Spigarelli, University of Macerata, Italy. The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of CDA, its Board of Directors, or the CDA Scientific Advisory Board. CDA does not guarantee the accuracy of the data included in this work.

Attribution — Sampaolo, Gianluca, Mihaela Roibu, Monica Lovito, Simone Padoan, Francesca Spigarelli, Ping Lv and Faxin Teng 2021. "A Case of Geo-Innovation in the 21st Century - Italy's Science, Technology and Innovation Partnership with China" CDA Systemic Country Insights (SCI) Publication Series, edition 1/2021, Vienna: China Data Analysis & Research Hub (CDA).

Cover design: University of Macerata.

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Peace is not everything,
But without peace everything is nothing.

Willy Brandt, former Chancellor of the Federal Republic of Germany
and Nobel Peace Prize laureate in 1971

PREFACE

With this initial edition of the novel publication series CDA Systemic Country Insights (SCI) the Sino-European brainport **China Data Analysis & Research Hub (CDA)** establishes a new scholarly platform for discourse between the West and China. In the coming decades we envisage to provide systemic and systematic analyses on a multitude of perspectives analyzing the Sino-European development between European countries, the European Union and EU Member States vis a vis the People's Republic of China. The editions of the SCI-series shall be published regularly over time but irregularly during the individual years. As a rule, the analyses are based on the use of European and original Chinese data alike in a synoptic approach combining the expertise of European and Chinese scholars.

Italy with its glorious past of the Roman Empire, being a G7 country as well as amongst the founding states of the European Union in the 20ies century, lends itself in an outstanding manner as a building block for exploring the evolution of the Sino-European relations – with all their opportunities and challenges. Witnessing gradually growing tensions between the West and China – nurtured by an underlying latent hegemonial dispute - CDA is dedicated to frame this development in a larger historical and global context. In the whitepaper for the Nobel Prize Summit 2021 "Our Planet, Our Future", held in April this year, Nobel Laureates and distinguished scholars made it clear that mankind has to obey the planetary boundaries and focus on collaboration to solve the Grand Challenges of the 21st century.

This time in history we must escape Thucydides' trap and the atavistic logic of escalation between competing nations. Instead, we have to develop a planetary awareness and a planetary patriotism to fulfill the next evolutionary step of mankind. Building on an unprecedented wealth of scientific knowledge we have the chance to join forces and learn together for the sake of our common future. Against this backdrop new forms of innovative solutions, global networks and future technologies pave the way for the emergence of geoinnovation as a novel phenomenon and powerful instrument of change complementing the mechanisms of geopolitics and geoeconomics.

With the Green Deal of the European Commission and the Circular Economy Law of the Chinese government the leaders of both world regions independently from each other expressed their insight in the necessity to follow the notion of a global community of shared destiny. However, we live in a time of transformation and imbalance seeking for novel reference points to explore common grounds for global problem solving beyond boarders – at the same time safeguarding our national identities and sense of security on individual level. Evidence-based decision making therefore always has to go hand in hand with a wise management of societal and economic transformation taking also into account bounded rationality of man while steering the ship through stormy waters.

In the year of Italy's G20 Presidency this CDA report provides initial data and background information on the strategic cooperation of Italy and China to foster global networks of innovation and learning. At the same time the two nations capitalize on the technological and economic opportunities combining their national systems of innovation to form a novel quality of application of research and knowledge – following a history of Sino-European knowledge exchange that already started with the Italian scholar Matteo Ricci living and doing research with scholars in China more than 400 years ago at the turn of the 16th to the 17th century.

It is therefore our pleasure to publish this first edition of CDA's novel publication series under the aegis of the University of Macerata – a genius loci of China research in Italy and the birthplace of Matteo Ricci – with major contributions of a leading institution of PR China's National Innovation System, the University of Chinese Academy of Sciences in Beijing. Against this backdrop I want to take the opportunity to thank all the distinguished scholars, experts and highly talented young researchers who contributed to this first edition of CDA's Systemic Country Insights (SCI) publication series.

In the spirit of CDA's motto "*Ex Sapientia Lux"* we wish the well-disposed audience a good reading.

Alexander G. Welzl
CDA President

Vienna on 11 September 2021

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INTRODUCTION

The present report comes under the scope of the **CDA Systemic Country Insights (SCI) Publication Series** which strives to provide facts and a deeper understanding of the bilateral collaboration between individual European countries and the People's Republic of China. It is the result of a collaboration between the China Data Analysis and Research Hub (CDA) and the China Center of the University of Macerata. As the first publication for the 2021 CDA SCI edition, the aim of the work is to investigate Science, Technology and Innovation (STI) relations between Italy and China and to provide an overall picture thereof.

The report is structured as follows. Section 1 frames the Sino-Italian STI partnership against the backdrop of geo-innovation and introduces the recent developments of China's domestic STI scenario following the adoption of two new strategic plans – the Belt and Road Initiative and the *Made in China 2025* – under the new presidency of Xi Jinping. Then a brief account of the implications resulting from the two new plans on China's STI bilateral relations with the West is given, with a focus on the Italy-China STI bilateral relations. Section 2 first illustrates the history of Italy-China STI relations and provides deeper insights on the type of STI initiatives and collaborations between the two countries at the institutional level, involving universities, research institutes as well as start-ups and SMEs. Section 2 then provides an analysis of the trends in FDI flows between Italy and China in the years 2010-2020, and the results are elaborated to give an account on the current state of affairs in the major industries where FDIs are realized. Section 3 illustrates the environmental protection and cooperation between Italy and China in the green sector as a case study, first by looking at the new Chinese market for environmental protection as the result of the reform policies introduced by the three most recent Five Year Plans. The Section then discusses business opportunities for Italian firms in the Chinese environmental market.

The report is the result of a joint research activity carried out by Gianluca Sampaolo, Mihaela Roibu, Monica Lovito, Simone Padoan, Professor Ping Lv and Professor Teng Faxin under the supervision of Professor Francesca Spigarelli. The introduction and the conclusions of the present work were jointly edited by the authors. The individual sections were edited as follows: Gianluca Sampaolo and Mihaela Roibu introduced the concept of Geo-innovation and analyzed the case for the Sino-Italian STI relations in Section 1. Monica Lovito explored the institutional relations and initiatives between Italy and China in Section 2.1 and analyzed the Italian FDI realm in Section 2.2.1 together with Mihaela Roibu. The analysis on the data of Chinese FDI realm was entirely carried out by Mihaela Roibu in Section 2.2.2. Simone Padoan described the context of China's market for environmental protection in Section 3.

1. Geo-Innovation: framing the case for Italy's Science, Innovation and Technology (STI) Partnership with China

At the turn of the 90s of the 20th century, globalization, especially that of multinational enterprises (MNEs), started proceeding at a fast speed. MNEs developed global value chains (GVCs) in order to lower their production costs and exploit new and more efficient opportunities in the field of R&D and innovation, by taking advantage of the global nature of the knowledge economy. Supply chains thus, became international not only with regards to the sourcing of raw materials and low-cost labor, but especially in their capacity to involve high-skilled actors operating in geographically dispersed specialized hubs, cities and clusters. In this way, GVCs experienced an evolution in both their tangible and intangible activities, allowing for the gradual emergence of global innovation networks. Gradually, innovation has started to be perceived not anymore as a phenomenon enclosed within the home country of MNEs operating in a variety of fields, but as the result of interactions and interchange between governmental institutions, companies and R&D centers active in different stages of the innovation process. The nature which defines innovation in the 21st century is indeed acknowledged to be both interactive and open. Interactive, in the sense that globally dispersed knowledge is brought together in a sole innovation process through exchange of information and experience by a variety of actors. While open, reflects the idea that companies and high-skilled personnel located in geographically distant locations and operating at different levels of GVCs can actively participate in the innovation process by sharing and re-combining their pool of knowledge. What is there to be gained for MNEs operating inside the framework of geo-innovation to develop both horizontal and vertical linkages, and in general for humanity as a whole, is that knowledge arising from a variety of local contexts can be pooled together to spur innovation-driven economic development and address challenges which are, indeed, global in nature. The results of such an effort to build global knowledge linkages are already supported by hard evidence proofing for the highly successful achievements of a consistent number of MNEs in their innovation processes. Building knowledge pipelines by offshoring innovation activities around the globe, in fact, allows firms to tap into geographically dispersed knowledge clusters or hubs, so as to diversify the firm knowledge base and speed up the acquisition of locally-specific knowledge inputs that would otherwise be difficult to generate internally. These achievements on corporate level are embedded in and supported by a nurturing environment of government policies as well as national research organisations' international agendas in developed countries and emerging economies.

Against this backdrop, strategic cases of MNEs which have at the basis of their successful history the deployment of a geo-innovation strategy can be made for the Chinese Huawei and US General Electric Company (GE). Huawei started its activities in 1987 in a newly opened-up to the world Shenzhen as an importer of analog telephone switches to become a global leader in the ICT field in about 30 years, ranking fifth at the global level in R&D expenditure. The firm gradually changed its management practices by importing best practices from successful Western firms it came to cooperate with, mixing them with a Chinese approach to business and innovation. Huawei is now China's most prominent MNE with sales worth a total of USD 105.2 billion in 2018 and operating in over 170 countries around the world, employing around 188,000 people, of whom are 45% focused on R&D[1]. To date, this

[1] Evidences for Huawei's European R&D-network and global innovation footprint are available at:
1. https://www.researchgate.net/publication/327411067_Industrial_upgrading_based_on_global_innovation_chains_A_case_study_of_Huawei_technologies_Co_Ltd_Shenzhen.

Chinese MNE operates within its European Research Institute (ERI) a network of 23 research sites in Europe.[2] With its ERI-headquarter in Leuven (Belgium,) the Munich Research Center in Germany is the largest European research facility of Huawei.[3]

A Western MNE which capitalizes on its international innovation network and knowledge flows is the GE company. Founded in 1892 through the merger of Edison General Electric Company and Thomson-Houston Electric Company, today the conglomerate focuses its operations in the four segments of aviation, healthcare, power, and renewable energy. GE has expanded globally to play a vital role in driving growth and competitiveness, especially through its operations in the European continent. In 2021, GE counted more than 92,000 employees dispersed in 900 locations around the globe and annual revenues of EUR 19 billion. Europe represents a hub of innovation for GE with over 20 industry focused R&D centers across the continent. Annually, about EUR 5 billion are invested by GE in R&D and approximately 30% of its global patents are filed in the region.[4]

The cases of Huawei and GE can be considered as iconic as for coining and introducing the novel term of geo-innovation into the global scholarly debate.[5] As seen in both cases, a special reference has to be made for the role global interactions and even alignments between MNEs and governmental policies in Science, Technology and Innovation (STI) play in creation a framework for geo-innovation. The complexity of establishing cooperation and advancing progress in STI requires a shared effort to widen the scope of knowledge search by building linkages to geographically dispersed locations. In fact, the cooperation between China and Italy in STI can be interpreted and framed into the geo-innovation domain, historically encouraged by the man who probably can be sanctioned as the forerunner of such a term and process, Father Matto Ricci.

Matteo Ricci (Macerata, 1552 - Beijing, 1610) was the first Westerner to establish a deep reciprocal relationship of knowledge and learning between Europe and China. He still remains today, for the two civilisations, a symbol and a model of mutual relations. Trying to describe the historic relations of two countries, and above all, two world-shaping cultures such as Italy and China, cannot transcend from mentioning the crucial role Father Matteo Ricci's scientific work, even nowadays, represents in bridging a distance of 9000 km, from Europe to China. From the point of view of dissemination, Father Matteo Ricci introduced Renaissance algebra to China, Euclidean geometry with the application to planetary motions and topography, the use of meridians and parallels, initiated the reform of the calendar and transmitted the techniques for building spheres, clocks, globes, quadrants as well as sextants. Neither an astronomer, nor a mathematician or even less a geographer, Father Matteo Ricci, with a precise pedagogical purpose, compiled some texts in Chinese that are of enormous historical interest, since in them the synthesis of substantial Western scientific knowledge was realized. However, being the first in history to introduce Chinese culture to Europe through the translation from Chinese to Latin of the *Four Books and Five Classics* (四书五经) of the Neo-Confucian tradition between

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2. https://www.researchgate.net/publication/340098400_The_Management_Transformation_of_Huawei_From_Humble_Beginnings_to_Global_Leadership.
3. https://www-file.huawei.com/-/media/corporate/pdf/event/hid2017/huawei_european_research_university_partnerships_michael_hill-king.pdf?la=en.

[2] See: https://huawei.eu/what-we-do/digital-transformation.

[3] See: https://www.effra.eu/huawei-technologies-duesseldorf.

[4] Further details for GE operations in Europe are available at: https://www.ge.com/europe/.

[5] Academic literature supporting the concept of geo-innovation is available at:
1. https://www.sciencedirect.com/science/article/pii/S109095162100033X.
2. https://www.unescap.org/sites/default/files/Chapter%209%20-%20GVCs%20and%20Technology.pdf.
3. https://english.boaoforum.org/u/cms/www2/202012/02171918h7e8.pdf.

1591 and 1594 is also considered among the biggest merits of Father Matteo Ricci. Furtherly, by collaborating with the Jesuit Michele Ruggieri, he compiled the first Portuguese-Chinese dictionary, providing a system of transliteration for Chinese words into Latin. By means of long transmission of indigenous texts, sixteenth-century Jesuit Fathers "fabricated" the figure of Confucius in the form of translations of the Chinese classics and transported it back to Europe, an effort which eventually influenced the works of thinkers such as Voltaire, Rousseau, Montesquieu, Comte, Quesnay, Fontenelle, Diderot, Leibniz, Malebranche and Bayle.

The Jesuits' attempts to take their mission to Asia and immerse themselves in Asian religion and culture manifested itself in a process of "going native" in order to aid in conversion. This process presupposed that the Asian Other could be perceived as equal to the European both intellectually and morally. The accommodation policy adopted by Matteo Ricci consisted of seeking out a common experience, locating lines of filiation, and working out acceptable compromises. Matteo Ricci's literary mission in China can be looked at as prefiguring the labor of comparing cultures, especially through his attempts to contextualize form and argument and his openness to hermeneutical play and dialogue. As such, the Latin language represented a bridge that allowed the encounter of two distant universes. Not by chance, despite the process of evangelization of China being his primary mission, Father Matteo Ricci can be considered a pioneer of geo-innovation in his attempt to connect the East and the West.

Building on such cultural and scientific heritage, 2020 marked an important anniversary in the relations between Italy and China, namely the 50th year since the establishment of diplomatic relations with the People's Republic of China. However, this anniversary coincided with one of the biggest global crises since the end of World War II, the Covid-19 pandemic. The 50th anniversary celebrations have almost all been canceled, and the future scenario is still to be deciphered. This uncertainty also extends to the scientific relations between the two countries which have experienced an important acceleration in recent years. Scientific diplomacy has played a very important role in increasing mutual knowledge beyond the utilitarian economic-commercial relations. Research, precisely in times of crisis, has proved to be an essential and unifying value of the globalized world. The solution of major crises such as that of the pandemic can only come from joint efforts and research. For this reason, it is easy to predict that scientific diplomacy will play a fundamental role in solving global challenges and reducing the possibility of conflict even at a time when geopolitical scenarios are becoming more uncertain and difficult to read.

In 2010, precisely on the occasion of the 40th anniversary of diplomatic relations between the two countries, China was a profoundly different country that still represented itself to the external environment following the "developing country's narrative". In that context, bilateral scientific relations were still essentially based on cooperation rather than collaboration. It was a phase that, seen in retrospect, was managed with little foresight, certainly not only on the Italian side as similar policies were followed by most European countries. The Chinese narrative was based on a very precise strategy, namely that of the acquisition and transfer of know-how and technologies from the West to China. There was little awareness that this was a structured and organized process. Bilateral relations in the scientific and technological sectors between Italy, Europe and China have, therefore, for a long time been marked by a certain naïve nature on the one hand and a prudent strategy of acquiring technologically important knowledge on the other. This process was accelerated with the new presidency of Xi Jinping whose international assertiveness led in a relatively short time to a strong confrontation on this very ground.

In the most recent phase, the Chinese strategy has changed and has become more decisive, moving towards the direct acquisition of Western technology companies. With the transfer of know-how through researchers who were invited to China and Chinese students trained abroad, it has just

become a complementary strategy. In addition to this direct front there is then the indirect one, based on the infringement of intellectual property and industrial espionage, as claimed by the United States Department of Justice.[6]

It has been further argued that Chinese policies represent a departure from traditional competition and international trade norms. Autarchy, not trade, defines China's goal. As such, China's economic strategy consists of two main objectives: to develop and support all sectors that can expand exports, especially those with higher added value, and reduce imports; and do it in a way that guarantees advantages to Chinese-owned companies.

In confirmation of this analysis, China has started a process of modernization of its industrial system, the *Made in China 2025* (MiC 2025) program, whose impact on international political economies has been poorly evaluated by China itself. The program, which even in its general lines had the purpose of tracing the value chain back to the Chinese industrial system and making it more competitive in general, contains quantitative objectives that unequivocally highlight that the main purpose is the achievement of technological self-sufficiency with potential closure of the internal market as a consequence. MiC 2025 has therefore generated profound external concern about what policies would have been in China's strategic technology sectors.

A technological cold war therefore broke out between the US and China, whose developments are still to be deciphered at the moment. The Trump presidency exacerbated the clash with China first on the economic front to then move on to the technological and the scientific one. Chinese students and researchers in the US have been subjected to tight scrutiny which has led to severe restrictions on visas and on the possibilities for scientific and technological collaboration. A new phase of confrontation between China and the US has begun, where scientific and technological supremacy appears at stake, a terrain where the US absolutely does not intend to give up its position of dominance. The confrontation has become particularly harsh on the front of 5G infrastructures. An example of this is the ban of Huawei technologies issued by the US in the first place. The Covid-19 pandemic has added to the problematic scenario of this crisis, with American accusations against China of having caused it with a leak of biological material from a Wuhan laboratory and then negligence in communicating and managing the epidemic.

Xi Jinping's presidency marked a turning point in Chinese foreign policy, which from Deng Xiaoping onwards had been based on prudence and avoiding direct confrontation with neighbors and more industrialized countries. Xi's new tool of foreign policy goes by the name of *Belt and Road Initiative* (BRI). Labelled as "the project of the Century" by President Xi Jinping this initiative is regarded as a vision for building up a comprehensive cultural, economic, and political network that promotes connectivity and cooperation between countries, regions, and cities along the Belt and Road routes, and it could spark a 21st-century expansion of global economic growth and technology exchange. This Chinese global undertaking in particular saw Italy as a protagonist. In fact, Italy was the only G7 country to sign a cooperation agreement with China on the so-called *New Silk Road* (BRI).

In the following paragraph, we focus on the status quo of the cooperation between China and Italy in the STI realm at the institutional level. An analysis of the ongoing projects between the two countries involving outstanding players such as universities and research centers specialized in a variety of cutting-edge fields and employing innovative technologies is performed.

[6] Further details are available at:
1. https://www.justice.gov/nsd/information-about-department-justice-s-china-initiative-and-compilation-china-related.
2. https://www.csis.org/programs/technology-policy-program/survey-chinese-linked-espionage-united-states-2000.

2. The status-quo of the Sino-Italian achievements in building a Sino-Italian STI-realm

2.1.1 *A timeline of the Sino-Italian STI Cooperation Agreements*

Cooperation on Science, Technology and Innovation (STI) between Italy and China started at a very early stage of China's opening up to the world, precisely in 1978 with an intergovernmental *Cooperation Agreement on Science and Technology* (S&T) signed by the two countries. This early framework agreement marked the beginning of a series of cooperation agreements that followed and have grown in number ever since. In 1984 Italy and China signed the *Cooperation Protocol on Science and Technology related to Space* to jointly foster development of space research and to deepen friendly relations between the countries. A second Protocol followed suit in 1987, the *Cooperation Protocol for Science and Technology on technology transfer and S&T exchange between institutions and universities*.

The most significant cooperation agreements were signed starting from 1998, as exposed in the timeline below:

I. On June 9th, 1998 in Beijing the Italian Republic and People's Republic of China signed the *Framework Agreement on Science and Technology.* The Framework replaced the 1978 *S&T Cooperation Agreement* and is renewed every five years. The Italian Parliament only ratified it in 2007. The cooperation promoted by the Agreement involves the following fields:

   A. Agriculture, fishing, animal husbandry and farming, and food
   B. Earth sciences, meteorology and oceanography
   C. Basic sciences (chemistry, physics, mathematics; etc.)
   D. Information technologies
   E. Energy and environment
   F. Advanced materials and superconductors
   G. Health, biomedicine, and biotechnologies
   H. Engineering and telecommunications
   I. Technologies for cultural heritage preservation
   J. Other sectors agreed upon by both countries

   With the 2007 ratification, the yearly allocation of public funds for the *Cooperation Agreement* was divided as follows: EUR 403,955 for the year 2007, EUR 395,675 for the year 2008, and EUR 403,955 yearly starting from the year 2009 onwards.[7]

II. In 2007 the Sino-Italian Exchange Event was created in Naples by the Città della Scienza and by Campania Region on the Italian side, and the Beijing Association for Science and Technology (BAST) and Beijing Municipality on the Chinese side.

III. In 2010, the first *Three-Year Action Plan on Economic Cooperation* agreement was signed, which envisaged the creation of the following forum as well as three bilateral cooperation centers: the China-Italy Innovation Forum; the Design and Innovation Center coordinated in Italy by the

[7] With the 2007 ratification, the yearly allocation of public funds for the *Cooperation Agreement* was divided as follows: EUR 403,955 for the year 2007, EUR 395,675 for the year 2008, and EUR 403,955 yearly starting from the year 2009 onwards. For more details see: http://documenti.camera.it/leg15/dossier/testi/es0050.htm#_ftn1.

Milan Polytechnic Institute; the E-Government Center coordinated in Italy by the Turin Polytechnic Institute; the Center for Technology Transfer coordinated by the University of Bergamo.

IV. In 2013 an Inter-Ministerial Agreement adopted by the Italian Government was signed by the Italian Ministry for Education, University and Research (MEUR), the Ministry for Economic Development (MED), the Ministry for Foreign Affairs and International Cooperation (MOFAIC, in Italian MAECI), the Italian Trade Agency (ITA, in Italian ICE), the Agency for a Digital Italy (in Italian AgID) and by Città della Scienza to create the *China-Italy Science, Technology & Innovation Program*. The Program is an important national platform whose objective is to coordinate the activities of the China-Italy Innovation Forum and the Sino-Italian Exchange Event and bring them together in a single format, the China-Italy Science, Technology & Innovation Week alternately organized in China and in Italy every year. Today, the Program is promoted by the two signatory Italian Ministries and the Chinese Ministry of Science and Technology, and is coordinated and managed by Città della Scienza and by the Beijing Municipal Science & Technology Commission (BMSTC) and the Beijing Association for Science & Technology (BAST). The activities and operations of the Program and of the Week are illustrated in a dedicated section below. [8]

V. In 2014 the Italian Government established a Technical Panel for S&T Cooperation with China, coordinated by the Italian MOFAIC. The Technical Panel is responsible for the promotion of knowledge on the Chinese scientific panorama; for fostering coordination among the Italian scientific and technological institutions cooperating with China; for the attraction of FDI in Italy to leverage the Country System and support cooperation. In the same year, the Italian MEUR expanded the range of activities promoted by the existing S&T cooperation program to include the dissemination of the scientific culture among its activities, via universities, Confucius Institutes in Italy and Città della Scienza, for the development of exchange programs, exhibitions, events and academic mobility.

VI. In 2015 the Italian MEUR and the MED established a Coordination Panel for the China Program to bundle all the Italian stakeholders from research institutions and universities and to promote matchmaking between innovative start-ups and enterprises with investors, thanks to the participation of Confindustria (the General Confederation of Italian Industry). Italy also manifested a strong interest in consolidating S&T cooperation with the National Natural Science Foundation of China (NSFC) after a reform of the national research system in China confirmed its central role in funding scientific research programs in basic sciences. In 2015 Ettore Sequi, former Italian Ambassador in Beijing, signed the *Joint Statement for the Implementation of the MoU* between the Italian MOFAIC and NSFC, with the NSFC President Yang Wei as signatory on the Chinese side.

VII. A new Italy-China cooperation instrument – the China-Italy Technology Transfer Centre (CITTC) – was launched in 2016 as the result of an agreement between the Italian MEUR, the Chinese Ministry of Science and Technology (MOST), University of Bergamo, University of Naples

[8] See for details: http://www.cittadellascienza.it/international-activities/china-italy-science-technology-innovation-program/?lang=en.

Federico II, Città della Scienza and NETVAL. The China-Italy Technology Transfer Centre was designed to become the backbone of technology transfer actions across Italy, providing technical support to Italian and Chinese programs.

2.1.2 *Italy-China Executive Programs for S&T Cooperation*

Since the signing of the 2010 *Three-Year Action Plan*, Italy worked on the implementation of Cooperation Programs to open and develop opportunities for bilateral scientific and technological cooperation. The *Italy-China Executive Programs for S&T Cooperation* (hereinafter Executive Programs) are coordinated by the Directorate General for Cultural Promotion and Cooperation of the Italian MOFAIC and by the Department of International Cooperation of the MOST of the People's Republic of China. The selection of project proposals to the Executive Programs takes place at the national level for a first screening, then a joint assessment is carried out by the Joint Committee to select projects admitted for funding. Preference is given to projects involving industrial counterparts, benefits from public or private research institutes and organizations, as well as participation in multilateral and/or European research programs (with a particular regard to the *Seventh Framework Program* of the EU). Over the years 2010-2021 Italy and China signed three Executive Protocols on bilateral cooperation agreements in the thematic fields of science, technology and innovation.

The first *Executive Program* was signed in 2009 and was valid for the 2010-2012 period. It provided financial support for a total of 35 research projects in the following priority areas: Agriculture and Food Safety; Aerospace Activities and Physics; Energy and Environment; Medicine and Traditional Chinese Medicine; Natural Risks Prevention; Technologies for Cultural Heritage Preservation.[9] The second *Executive Program* was approved in 2012 and was implemented in the years 2013-2015. The priority areas for research projects and exchanges of the second program were outlined as follows: Applied Basic Sciences (Chemistry, Mathematics and Physics); Biotechnology and Medicine; Energy and Environment; Information Communication Technology; Nanotechnology and Advanced Materials; Space and Aeronautics; Technology Applied to Cultural Heritage. A total of 31 projects were approved and received financial support by the Italian and the Chinese sponsoring Ministries.[10] In 2015 Italy and China signed the third *Executive Program* for the years 2016-2018 for projects in the following priority research areas: Biotechnology and Medicine (proteomics and genomics, cancer research, neurodegenerative and cardiovascular pathologies, regenerative medicine); Environment (soil remediation, water purification and pollution detection); Nanosciences and Advanced Materials; Physics (high energy physics); Aerospace (deep-space exploration, remote sensing); Sustainable urbanization (smart city, internet of things, ICT).

At the time of writing (July 2021), *S&T Cooperation Executive Programs* between Italy and China are pursued under two active Protocols. The first is the *Executive Program of Scientific and Technological Cooperation* between Italy and China for the years 2019-2021 signed by the Directorate General for Economic and Cultural Promotion and Innovation of the Italian MOFAIC and by the Department of International Cooperation (DIC) of the Chinese MOST, similarly to the previous three editions. The program's deadline has been extended to December 31st, 2022. The research projects selected by the program are 9, pertaining to the following priority areas: Artificial Intelligence (Brain-Inspired Artificial

[9] See for details: http://www.miur.it/UserFiles/3212.pdf.
[10] See for details: https://www.esteri.it/mae/doc_politica_estera/cultura/cooperscientificatecnologica/programmi%20esecutivi/pe_italia_cina_2013_2015.pdf.

Intelligence, Intelligent City); Technologies related to Astrophysics; Innovative Processes for Biomass Conversion into Energy and other added value products; Innovative Biomedical Devices (medical robots, tissues engineering, new therapeutics, neurodegenerative diseases and personalized medicine).[11]

Following the signing of the MoU between the Italian MOFAIC and the National Natural Science Foundation of China (NSFC) in 2015, in 2017 the Sino-Italian S&T cooperation launched a new, still ongoing *Executive Protocol on Collaborative Research Projects* for the years 2018-2020 (extended to December 31 2021), financed by the Italian MOFAIC, MEUR and the NSFC. The priority areas for research projects include New Materials (with a particular reference to two-dimensional systems and graphene); Environment (Urban Circular Economy); Physics and Astrophysics (quantic technology and dark matter); Health (personalized and genomic medicine, and chronic diseases). The Evaluation Committee selected 10 research initiatives for the receiving of joint financing, 4 of which in the research area of Health, 3 in New Materials, 2 in Physics and Astrophysics, and 1 in Environment.[12]

2.1.3 *Significant Bilateral Projects ("Progetti di Grande Rilevanza")*

Significant Bilateral Projects (it., Progetti di Grande Rilevanza) are research projects eligible for an annual special financial contribution granted by Italy and China on a co-funding or national basis. Such projects are part of the Executive Programs and constitute a short-list of projects entitled to apply for funding following the requirements indicated in the specific call for proposals issued by the Unit for Scientific and Technological Cooperation, Directorate General for Country Promotion (Economy, Culture and Science) of the Italian MOFAIC.[13] **Table 1** illustrates the list of Significant Bilateral Projects approved for annual funding for the years 2015-2020.

Table 1: Significant Bilateral Projects under the Italy-China S&T Cooperation Executive Programs (2015-2020).

Year	Research Area	Proposing Italian Institution	Proposing Chinese Institution	Project Title
2015	*ICT*	*University of Rome Biomedical Campus*	*Henan University*	*Classifying Medical Data Streams with Skewed Distributions: Application to Indirect Immunofluorescence Image Analysis*
2015	*Applied Sciences*	*Italian National Institute for Nuclear Physics (INFN)*	*Institute of High Energy Physics (IHEP)*	*Experimental study on the phase between strong and electromagnetic interactions*
2015	*Biotechnologies and Medicine*	*University of Pisa*	*Sun Yat-Sen University*	*Development of Novel Multi-targeted Anti-Alzheimer's Disease Drug*
2015 - 2017	*Applied Sciences*	*INAI*	*University of Science and Technology of China*	*Constraints on Dark Energy and Dark Matter from Clusters of Galaxies*

[11] See for details: https://www.esteri.it/mae/resource/doc/2019/08/programma_esecutivo_scientifico_tecnologico_2019_2021_italia_cina.pdf
[12] See for details: https://www.esteri.it/mae/resource/doc/2017/11/joint_statement_maeci_nsfc_firmato.pdf.
[13] See for details: https://www.esteri.it/mae/it/politica_estera/cooperscientificatecnologica/programmiesecutivi/20120711_call_italia_cina_2013_2015.html.

2015 - 2017	*Biotechnology and Medicine*	*Italian National Institute of Health (ISS) - MIPI*	*Sichuan University*	*The genomics of antimicrobial resistance in bacterial pathogens of relevance for human health*
2015 - 2017	*ICT*	*University of Calabria*	*Wuhan University of Technology*	*Smart Personal Mobility Systems for Human Disabilities in Future Smart Cities*
2015 - 2017	*Nanotechnologies and Advanced Materials*	*University of Salerno*	*Second Military Medical University*	*Inverse virtual screening and chemical proteomics applied to the identification of novel biological targets for bioactive natural compounds isolated from Chinese marine organisms*
2015 - 2017	*Biotechnology and Medicine*	*European Institute of Oncology, IEO*	*Chongqing Haifu Medical Technology Co., Ltd.*	*R&D and Application of imaging-fusion technology in the guidance of HIFU treatment for breast cancer*
2015 - 2017	*Nanotechnologies and Advanced Materials*	*National Nanotechnology Laboratories (NNL) Italy*	*Jilin University*	*Flexible Transparent White Organic Light Emitting Device (FT_WOLED)*
2015 - 2017	*Energy and Environment*	*ENEA*	*Harbin Institute of Technology*	*Optimized bioconversion of crude glycerol into hydrogen and ethanol using Geo-Chip and coupling with MEC*
2016 - 2018	*Nanosciences and Advanced Materials*	*CNR – DSCTM*	*NA*	*Graphene-based hybrid materials for energy sector and environmental protection applications*
2016 - 2018	*Biotechnologies and Medicine*	*INFN – Milan and Pavia Divisions*	*NA*	*NEU BEAT (NEUtron BEAms for cancer Treatment)*
2016 - 2018	*Sustainable Urbanization (smart city, IoT, ICT)*	*Polytechnic of Turin*	*NA*	*Italy-China Lab for Smart Cities*
2016 - 2018	*Sustainable Urbanization (smart city, IoT, ICT)*	*Sant'Anna School of Advanced Studies (SSSA) – TeCIP Institute*	*NA*	*CANTON – High Speed Optical Switch in Integrated Photonics*
2016 - 2018	*Environment*	*CNR – Institute for Ecosystems Studies*	*NA*	*Effectiveness of different disinfection processes in use and experimental in removing the determinants of antibiotic resistance in wastewater*
2016 - 2018	*Environment*	*University of Padua*	*NA*	*Remediation of old landfills for environmental sustainability and final storage*
2016 - 2018	*Physics*	*INFN – Rome Division*	*NA*	*Production of ultra radio-pure NaI (Tl) crystals for the search for dark matter*
2016	*Biotechnologies and Medicine*	*Catholic University of the Sacred Heart*	*NA*	*Italian-Chinese laboratory on genomics, translational medicine, clinical research on lung cancer*

2016 - 2018	*Nanosciences and New Materials*	*University of Messina*	*NA*	*Broadband microwave nano-receivers based on spin magnetic moment transfer*
2016 - 2018	*Biotechnologies and Medicine*	*IRCCS Galeazzi Orthopedic Institute*	*NA*	*Numerical assessment of the risk of fractures in the metastatic spine*
2016 - 2018	*Aerospace*	*ENEA – Department of Energy Technologies*	*NA*	*Refractive index engineering for remote detection from space*
2016 - 2018	*Biotechnologies and Medicine*	*Italian National Institute of Health (ISS) – Dep. of Cellular Biology and Neurosciences*	*NA*	*DNA repair stimulation as an innovative therapeutic approach for Alzheimer's disease: chemically derived neurons from Alzheimer's patients fibroblasts as a new model*
2016 - 2018	*Biotechnologies and Medicine*	*IRCCS Institute for Auxology*	*NA*	*Effects of intensive antihypertensive treatment on stiffness of large arteries as a risk of stroke in adult hypertensive patients*
2016 - 2018	*Biotechnologies and Medicine*	*ISS – National Center for Epidemiology, Surveillance and Health Promotion*	*NA*	*Pollution and epigenetic modifications associated with cardiovascular pathology in cohorts of newborns and adults in Italy and China*
2018 - 2020	*Physics and Astrophysics (with particular reference to quantum technology and dark matter)*	*University of Brescia – Dep. of Information Engineering*	*Northeast Normal University*	*Harnessing Color Entanglement for Information and Communication Technologies*
2018 - 2020	*Health (with particular reference to personalized Medicine, Genomics and chronic diseases)*	*University of Turin – Dep. of Molecular Biotechnologies and Health Sciences*	*Shanghai JiaoTong University*	*Mechanisms of genomic instability and resistance / progression to therapy caused by AID in chronic lymphocytic leukemia*
2018 - 2020	*Health (with particular reference to personalized Medicine, Genomics and chronic diseases)*	*La Sapienza University of Rome – Dep. Of Anatomical, Histological, Medico-legal and Musculoskeletal Sciences*	*Southeast University*	*Microenvironment-regulated Acetate metabolism pathway on colorectal cancer metastasis and prognosis*
2018 - 2020	*Physics and Astrophysics (with particular reference to quantum technology and dark matter)*	*INFN – Padua Division*	*IHEP*	*Innovative electronics for the determination of the neutrino mass hierarchy and dark matter searches with the JUNO experiment, to nuclear reactors*
2018 - 2020	*New Materials, with particular reference to Two-dimensional systems and graphene*	*University of Padua – Dep. of Chemical Sciences*	*Peking University Beijing*	*Graphene and related Innovative 2D materials for sustainable energy development and catalysis (GINSENG)*
2018 - 2020	*New Materials (with particular reference to Two-dimensional systems and graphene)*	*CNR – Institute for Membranes Technologies (ITM)*	*Nanjing Tech University*	*New nanostructured membranes prepared from 2D materials for the development of newly conceived production processes dedicated to the supply of fresh water and gas purification (2DMemPur)*

2018 - 2020	*New Materials (with particular reference to Two-dimensional systems and graphene)*	*INFN – National Laboratories in Frascati*	*Beijing Institute of Technology*	*3-Dimensional Graphene: Applications in catalysis, photo-acoustics and plasmonics*
2018 - 2020	*Environment (with particular reference to Urban Circular Economy)*	*University of Naples "Parthenope" – Dep. of Sciences and Technologies*	*Beijing Normal University*	*Analysis of the metabolism of urban conglomerates and the cooperative strategy of the circular economy*
2018 - 2020	*Health (with particular reference to personalized Medicine, Genomics and chronic diseases)*	*Immacolata Dermopatie Institute- IRCSS-FLMM Lab of Skin Biochemistry at Dep. of Experimental Medicine and Surgery*	*Shanghai Institutes Biological Sciences*	*The role of the p53 family members in bone remodeling and in the development of osteosarcoma*
2018 - 2020	*Health (with particular reference to personalized Medicine, Genomics and chronic diseases)*	*IRCCS Humanitas Clinical Institute – Unity of Rheumatology and Immunological Clinic*	*Xiangya Hospital, Central South University*	*DNA and microRNA methylation as biomarkers to predict psoriatic arthritis onset in monozygotic twins with psoriasis*
2019 - 2021	*Innovative biomedical devices*	*University of Rome "La Sapienza" – Dep. of Information, Electronics and Telecommunication Engineering.*	*Tianjin University*	*Integrated micro-device for DNA analysis using acoustic and fluid techniques*
2019 - 2021	*Innovative biomedical devices*	*University of Milan Bicocca – Dep. of Biotechnologies and Biosciences*	*Peking Union Medical College Hospital*	*Preclinical evaluation of a PGM3 inhibitor as an innovative approach in the therapy of pancreatic ductal adenocarcinoma*
2019 - 2021	*Innovative processes for biomass conversion into energy and other added value products*	*University of Trieste – Chemical and Pharmaceutical Sciences*	*Dalian Institute of Chemical Physics*	*Photocatalyzed Selective Transformation of Lignocellulose with hydrogen production*
2019 - 2021	*Innovative biomedical devices*	*IRCCS – Neuromed Mediterranean Neurological Institute*	*Tongji Hospital Huazhong University of S&T*	*Early prediction and dynamic assessment of AD through new imaging-based digital PET techniques and analytical models*
2019 - 2021	*Technologies related to astrophysics*	*National Astrophysics Institute (INAF) – Turin Astrophysics Observatory*	*Shanghai Astronomical Observatory, CAS*	*Scientific and technological developments of Astrometry for Astrophysics*
2019 - 2021	*Innovative processes for biomass conversion into energy and other added value products*	*University of Calabria – Dep. of Environment Engineering and Chemical Engineering*	*China University of Petroleum*	*Biowaste to Chemicals and Liquid Fuels -B2CLIF*
2019 - 2021	*Artificial Intelligence*	*Polytechnic Institute of Milan – Dep. of Electronics, Information and Bioengineering*	*Northeast Normal University*	*MIND: Memristive brain-inspired neuromorphic devices*
2019 - 2021	*Artificial Intelligence*	*University of Trento – Dep. of Engineering and Information Science*	*Peking University*	*Joint UAV and Surveillance Video Content Analysis and Mining for Smart City (TALENT)*

2019 - 2021	*Technologies related to astrophysics*	*ENEA – Dep. of Energetic Technologies*	*Shanghai Institute of Optics and Fine Mechanics, CAS*	*Effects of the space environment on optical and electronic devices for astrophysical space missions*
2019 - 2021	*Innovative biomedical devices*	*University of Turin – Dep. of Molecular Biotechnologies and Health Sciences*	*Fudan University*	*Acustofluidic DNA Diagnosis Chip (ADD-Health) Glioma surgery navigation system based on surface enhanced Raman scattering (SERS) technology*

Source: Author's own elaboration on data from the Italian Ministry of Foreign Affairs and International Cooperation.[14]

[14] For further details, see: https://www.esteri.it/mae/it/politica_estera/cooperscientificatecnologica/programmiesecutivi/progettigranderilevanza/.

2.1.4 *Italian National Research Council (CNR) - China bilateral agreements*

This section explores the most prominent collaboration between the Italian National Research Council (CNR) and China. The CNR is the main public research body of Italy under the supervision of the Ministry of Education, University and Research. With its over 100 specialized research institutes, the role of the CNR is to carry out scientific and technological research projects, as well as to transfer, promote and disseminate the results of its activities. According to a ranking published in *Nature,* in 2018 the CNR was 10th among the world's research institutes for number of published scientific articles. The CNR may sign bilateral S&T cooperation agreements as well as MoUs with similar institutes in foreign countries.

Since 2008, CNR has signed bilateral agreements with Chinese research institutes over a wide range of priority research areas. The first bilateral agreement for a joint research project was signed with the Chinese Academy of Agricultural Sciences (CAAS) for the years 2008-2010 in the field of Chemical Sciences and Material Technologies. Cooperation continued until 2019. In 2016, CNR activated 6 joint research projects with the Chinese Academy of Cultural Heritage (CACH) for the years 2016-2018, and 4 new projects in the years 2019-2021. Since 2017, CNR also has active agreements with the Chinese Academy of Sciences (CAS). For the three-year period 2017-2019 the two organisations funded 3 joint research projects in Bio-Food Sciences, Earth System Sciences and Environment Technologies, and Chemical Sciences and Material Technologies. In 2019, a new call for project proposals for the years 2020-2022 selected 3 joint research projects in the areas of Applied Physics, Geosciences and Earth Resources, and Chemical Sciences and Technologies. A total of 4 ongoing CNR co-funded research projects for the years 2021-2022 are part of the bilateral agreements with the Chinese MOST signed in 2017, in the fields of Chemical Sciences and Technologies, Marine Engineering, Materials for Electronics and Magnetism, and Sustainable Plant Protection. In 2019, the CNR signed the most recent bilateral agreement with the National Natural Sciences Foundation of China (NSFC) for the years 2021-2022. The projects accepted for funding are 5, in the fields of Construction Technologies, Chemical Sciences and Technologies, Membrane Technologies, Nanosciences, and New Materials.[15]

Perhaps the most significant collaboration of the CNR with Chinese research institutes is the MoU signed by the CNR Cell Biology and Neurobiology Institute (IBCN) in Rome Monterotondo with ShanghaiTech University for joint research projects and exchange of researchers and staff. The main research project coordinated by Prof. Fabio Mammano, director of IBCN with Shanghai Tech University focuses on the study of therapeutic antibodies. At present, ShanghaiTech hosts two Italian associate professors, Francesco Zonta and Camilla Lumi, both engaged in biomedical research.

2.1.5 *Italy's National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) bilateral agreements with China*

ENEA, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile), is currently signatory of two MoUs with China. The first MoU was signed in 2017, with the Hefei Institutes of Physical Science, Chinese Academy of Sciences (CASHIPS) for a 5-year scientific cooperation on technologies for nuclear applications of heavy liquid metals. The second MoU, signed in 2018 with

[15] For more details on the CNR bilateral agreements with China and on ongoing joint projects, see https://www.cnr.it/it/accordi-bilaterali

the Chinese Academy of Sciences (CAS), pertains to cooperation on nuclear fission and fusion. Moreover, ENEA is involved in a Significant Bilateral Project coordinated by the Shanghai Institute of Optics and Fine Mechanics (SIOM) for the investigation on the effects of the space environment on optical and electronic devices developed for astrophysics space missions.[16]

2.1.6 *Technical Panels for Italy-China S&T Cooperation and the Italy-China Action Plan towards 2025 (Piano d'Azione Italia-Cina verso il 2025)*

Since 2014, Technical Panels involving a committee of experts on Italy-China S&T Cooperation and discussions have been held by the Italian MOFAIC to collect proposals from the main stakeholders involved in research and innovation in the Italian scientific and business community. The meetings are chaired by the Director General for Innovation and Research of the MOFAIC, and involve the participation of the Italian diplomatic missions in China, namely the Italian Embassy in Beijing, the General Consulate in Chongqing, the General Consulate in Shanghai, and a representative for the Italy-China Innovation Week of the MEUR.

In March 2020, the Italian MOFAIC, together with the accredited Italian Scientific Officers in the People's Republic of China and the members of the Technical Panel for Italy-China S&T Cooperation, published a report titled *Italy-China Action Plan towards 2025 (Piano d'Azione Italia-Cina verso il 2025*[17], hereinafter Action Plan) with the aim of extending Italy's support to cooperation in the years to come, on the basis of reciprocity, transparency, inclusivity and sustainability. A previous similar document titled *Common Strategy for Cooperation in the fields of Science, Technology and Innovation between China and Italy towards 2020* (*Strategia comune per la Cooperazione nei settori della Scienza, Tecnologia e Innovazione tra Cina e Italia verso il 2020*) was published after the Chinese 13th FYP (2016-2020) – in line with the National Plan for Research (2015-2020) of the Italian Government. The Action Plan outlines current efforts and new opportunities of cooperation between the two countries in eight key areas of science and technology, namely (i) physics, geophysics and space; (ii) new materials; (iii) environment and energy; (iv) sustainable urbanization; (v) new technologies for cultural heritage; (vi) agriculture; (vii) biosciences, health and wellness; (viii) industry 4.0. Each of the key areas illustrated in the Action Plan is articulated in three subsections and provides details on cooperation measures, namely (r) research, (ra) applied research, (ct) technological cooperation. More cooperation initiatives between Italy and China are also encouraged in the fields of aviation, automotive, smart transportation systems, railway transportation systems, Small and medium-sized enterprises (SMEs) cooperation, Intellectual Property (IP) regulations, industrial energy efficiency and reduction of emissions; industrial design, technical certification standards and regulations; use of blockchain technologies in applications to diverse industries; green growth and energy revolution; maritime projects; and the agri-food sector.

The following subsections illustrate the most relevant examples of cooperation activities in key research areas highlighted in the Action Plan.

- ***Smart Manufacturing and Robotics***

The Action Plan calls for a sustained Italian contribution in the field of Smart Manufacturing through the bilateral platform on advanced manufacturing, whose foundation was agreed upon in

[16] For details, see: https://www.enea.it/it/internazionali/relazioni-internazionali/cooperazione-scientifica-e-tecnologica/cooperazione-bilaterale.
[17] For details see: https://www.esteri.it/mae/resource/doc/2020/03/piano_dazione_st_verso2025r.pdf

Beijing in November 2017. The China Italy Lab on Advanced Manufacturing (CI-LAM), the platform born in 2017, is coordinated in Italy by the China Italy Technology Transfer Center (CITTC). Founding partners of the CI-LAM are Tsinghua University, the University of Bergamo, the University of Naples – Federico II, Campania Newsteel and China Sci-Tech Automation Alliance. In 2020 SPICI srl and E-Cube joined the CI-LAM as associated partners. As described on the CI-LAM website, the mission of the platform is to promote and enhance the results of a joint research and development collaboration within the field of Smart Manufacturing, including mutual technology transfer, demonstrative applications and commercialization, using a win-win approach. The platform pools the resources of start-ups, enterprises, universities, research institutions and consulting companies to carry out application-oriented R&D and product innovation, helping manufacturing enterprises in both countries – SMEs and start-ups in particular – adopt the new industrial paradigms and embrace key enabling technologies, and promoting matchmaking activities inside. CI-LAM aims to address the future challenges in manufacturing and carries out innovation in standards and interoperability, working with the international organization for standardization. Furthermore, the CI-LAM organizes training, exchange and mobility programs for students, academics and professionals.[18]

- ***New Energy Vehicles***

The Action Plan stresses the importance of a mid-term plan that allows to leverage the ongoing collaborations between the main Chinese enterprises with offices or joint-ventures in Italy. Examples include Chang'an, a State-Owned automotive enterprise headquartered in Chongqing with a R&D department in Turin specialized in styling and bodywork. One more example is Jac (Anhui Jianghuai Automobile Co., Ltd.), a SOE with headquarters in Hefei and a R&D department in Turin. As for sea vessels and shipping, two state giants – Fincantieri on the Italian side and China State Shipbuilding Corporation – have signed important cooperation agreements, similarly to Azimut Benetti and Ferretti Yachts with Chinese counterparts.

- ***New Materials***

Specific interests and priority areas for the Italy-China bilateral S&T cooperation include new and advanced materials as well as nanotechnologies in the following fields: transportation (sensors and composite materials with characteristics of lightness and multifunctionality), energy and environment (membranes, semiconductors and sensors), medicine and health (biomaterials, tissue engineering, drug delivery), construction (photovoltaic and thermal insulation materials), cultural heritage (preservation materials and technologies for detection and diagnostic).

- ***Green growth and energy revolution and the Sino-Italian Cooperation Program for Environmental Protection (SICPEC)***

Cooperation in this field is particularly encouraged in the following areas: air, water and soil pollution; remediation of polluted sites; sustainable mobility infrastructure; energy efficiency and renewable energies; energy storage and CO_2 sequestration; waste management, including hazardous waste. Against this background, it is paramount to highlight the cooperation between Italy and China in environmental protection. Following a *Joint Statement on the Sino-Italian partnership for sustainable and*

[18] See for details: https://www.cilam.org/about-mission/.

green development signed in 2014 by the Italian Ministry of the Environment and the Chinese Ministry of Environment Protection (MEP), the *Sino-Italian Cooperation Program for Environmental Protection* (SICPEC) was launched. Within the framework of the SICPEC, the Italian Ministry of the Environment and the Chinese Academy of Social Sciences launched an *ad hoc* collaboration, the Tailored Advisory Service (TAS), to facilitate targeted contacts between Italian and Chinese enterprises. Through the TAS project, a Help Desk was activated in Beijing to assist Italian enterprises willing to enter the Chinese market for environment technologies. SICPEC provided training programs, such as the 2016 *Sino-Italian Advanced Training Program on Environmental Management and Sustainable Development*, which involved several Chinese Ministries and public bodies, such as the MEP, Beijing EPB and Shanghai EPB, the National Development and Reform Commission (NDRC), the Ministry of Industry and Information Technology (MIIT), and the MOST. The same Program was activated in the years 2017-2018 and involved the same public bodies and ministries, including the Foreign Economic Cooperation Office of the MEP and the Tianjin Science and Technology Commission of Tianjin Municipality. A number of projects have been implemented since the launch of SICPEC. Examples include the TWEES - Tongzhou Water Environment Evaluation and Strategy, whose mission was to provide technical support in the implementation of the *Beijing Water Pollution Prevention and Control Plan* and the *Beijing-Tianjin-Hebei Integrated Development Strategy* (BTH) of the Municipality of Beijing. More cooperation projects include: the creation of an Italian Hub in the 3IPET (International Platform for Environmental Technology); two *Projects of Great Importance of the Italy-China Executive Program* in 2016; the *Particulate Matters Monitoring Project* for capacity building on monitoring air quality and pollution ($PM_{2.5}$); the *Radiation Management Project*; the *Technical Assistance on Capacity Building for the Management and Control of Air Pollution Sources* (Emission Inventory Project Phase II); Technical Support for the *World City Environment Target Study Program Year 1+2: Beijing Environment Master Plan; Low-Nitrogen Gas-fired Boiler Pilot Project*; *Climate Change City Adaptation in China*; *Improvement of the Energy Efficiency Performance of the Yunchou Building* with the Tongji University of Shanghai.[19]

- ***The space sector***

One of the most interesting results of Italian scientific diplomacy with China in the decade 2010-2020 is precisely in the space sector. It is one of the most delicate and difficult to manage areas of cooperation due to its technological and military implications. In 2011, the Italian Space Agency (ASI) signed a framework agreement with the China National Space Administration for cooperation in the space sector. This framework agreement was followed by an executive agreement for the construction of a joint satellite, the China Seismo Electromagnetic Satellite.

Italy has also made a decisive contribution to the realization of the first scientific satellite launched by China on December 17, 2015, Dark Matter Particle Explorer (DAMPE[20], in Chinese baptized Wukong), the result of a collaboration between the CAS and the National Institute of Nuclear Physics. This collaboration is the result of an agreement between ASI and the National Space Center of the CAS and is part of the cooperation in the specific sector of space science.

[19] See for details: https://www.mite.gov.it/sites/default/files/archivio/allegati/sviluppo_sostenibile/cooperazione_italia_cina_protezione_ambiente_2016_17.pdf.

[20] Dampe is a used space telescope for the detection of high-energy gamma rays, electrons and cosmic ray ions, to aid in the search for dark matter. It was designed to look for the indirect decay signal of a hypothetical dark matter candidate Weakly Interacting Massive Particles (WIMPS).

Another project that has been carried out and which has an important symbolic value is that of mapping the moon. The project, personally commissioned by the Chinese Minister of Science and Technology, used data from the Chinese lunar probes of the Chang'e series to create a map of the distribution of the elements on the lunar soil. A peculiarity of this project is that it was carried out in collaboration by Chinese and Italian university students.

The signing of the agreement between ASI and the China Manned Space Agency for the collaboration and construction of the Chinese space station Tiangong 3 represented another important moment. This agreement was also signed on the occasion of President Mattarella's visit to China on February 22, 2017 in the presence of his Chinese counterpart President Xi Jinping. The signing of this agreement was perhaps a turning point and marked the point of maximum scientific and technological collaboration between Italy and China. In fact, immediately in the aftermath of the signing, talks for Italian participation in the construction of the Chinese space station began quite quickly.
Furthermore, on March 12, 2019 Italy was the first nation to sign the inter-governmental convention on the establishment of the Observatory Square Kilometer Array (SKA). China was also a signatory of the agreement, this way entering a cooperation involving, among others, Italian and Chinese industries in the construction of antennas and receivers for the project.

The most important success of the bilateral collaboration in the space sector between Italy and China was the launch on February 2, 2018 of the CSES satellite[21] (China Seismo-Electromagnetic Satellite) from the Chinese space base of Jiuquan Satellite Launch Central in the Gobi Desert (Inner Mongolia) using the Long March 2D vehicle. CSES was a joint Sino-Italian space mission and Italy was the first Western country – not considering the European initiative for the launch of a satellite between the European Space Agency and China – to launch a satellite in collaboration with China, a small record that allowed the country to gain the trust of Chinese colleagues and project the image of Italy outside the stereotypes of the "3Fs" (food, fashion and furniture). CSES is a satellite for the study of the magnetic field, plasma and particle flows in the earth's orbit. As Principal Investigator, Italy, coordinated the projects through the LIMADOU project[22] (the Chinese name of Father Matteo Ricci) headed by Professor Piergiorgio Picozza, with the joint collaboration and funding of the ASI and the INFN (including the divisions of Bologna, Naples, Perugia, Rome Tor Vergata University, TIFPA, the National Laboratories in Frascati, University of Bologna and Trento, Uninettuno, the Italian National Institute of Astrophysics and Planetology INAF-IAPS, and the Italian National Institute of Geophysics and Volcanology INGV). Italy, therefore, has made a decisive contribution thanks to the technology of particle detectors, creating the High Energy Particle Detector (HEPD), and collaborating in the construction of the Electronic Field Detector. The launch of the satellite was greeted by messages of mutual congratulations between the two Presidents Mattarella and Xi Jinping. Thanks to the success of the first satellite, on the occasion of President Xi Jinping's state visit to Italy in 2019, an agreement was signed for the construction of CSES-02, which is now at an advanced stage of development. However, the global geopolitical framework as well as the changed internal political conditions have led Italy to make a real reverse in collaboration with China in the space sector.[23]

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[21] The mission of the CSES is to monitor electromagnetic waves and fields, the plasma parameters and particle fluxes generated by natural sources and artificial emitters in near-Earth space. The aim of the mission is to verify the existence of possible spatial and temporal correlations between the observation of perturbations in the ion-magnetosphere and the occurrence of seismic events.
[22] See for details: https://www.asi.it/en/earth-science/cses-mission-limadou-italian-contribution/.
[23] Stefano Pioppi, "Così l'Italia ritrova la bussola spaziale (meno Cina e più Usa). Tutte le mosse del governo": https://formiche.net/2020/01/italia-stati-uniti-cina-luna-spazio/.

- ***Physics and Geophysics***

An important moment in bilateral relations was the implementation of the Strategic Bilateral Cooperation Plan in the scientific and technological fields and the opening of the permanent Technical Panels for scientific cooperation at the Italian MOFAIC. The implementation came along with the opening of the scientific offices at the Shanghai and Chongqing Consulates with the appointment of two new scientific officers.
On the basis of the Strategic Plan, priority areas for cooperation have been identified, underlining the need to focus collaboration on basic science sectors. For this reason, a bilateral cooperation agreement was negotiated and then signed with the NSFC – the Chinese government agency that deals with the funding of basic research. Italy was one of the few countries that did not yet have a bilateral agreement with the NSFC. China has substantial research funding available and scientific cooperation agreements within the Executive Programs are funded on an equal basis (this is not the case, for example, with the United States or with Japan).
Another important milestone in scientific collaboration reached by Italy is the cooperation in designing the Jiangmen Underground Neutrino Observatory (JUNO). The idea behind the JUNO experiment is to determine the neutrino mass hierarchy and accurately measure the oscillation parameters by detecting neutrinos emitted by the reactors of nearby Yangjiang and Taishan nuclear power plants, observing supernova neutrinos, studying neutrinos atmospheric, solar and geo-neutrinos. A 20,000-ton scintillator detector with an unprecedented energy resolution of 3% (at 1 MeV) at 700 meters underground depth is used for the experiment. The INFN is the main foreign partner in this collaboration thanks to the experience accumulated in neutrino physics at the Gran Sasso National Laboratories. The JUNO experiment in China is one of the main big science experiments in which Italy is involved outside of Europe.
Another important result is the collaboration between INFN and its Chinese equivalent, the Institute of High Energy Physics (IHEP) of the Chinese Academy of Science (CAS) for the construction of the IHEP-INFN Joint Laboratory (I2JL) in Beijing and collaboration in the field of accelerator physics (BesIII collaboration).
In May 2018, a Chinese delegation from the Hefei National Synchrotron Radiation Laboratory (NSRL) visited the facilities of the Elettra Synchrotron in Trieste, Italy, the international research center of the Trieste Science Park Area specialized in the study of materials using synchrotron light. The delegation manifested great interest in the advanced technologies utilized in the Italian synchrotron, particularly for its ductility, flexibility and with fewer maintenance problems than other similar facilities. During the visit, the Chinese delegation seized the opportunity to sign a MoU for technology cooperation and exchange of staff and experts. According to the Action Plan, Italy is now willing to participate in the call of the Chinese Academy of Sciences for a project on the realization of the New Chinese National Synchrotone.
Finally, the two countries are willing to carry on cooperation in the experiments BesIII, JUNO, DAMPE, as well as SKA demonstrating that bilateral collaboration in the field of particle physics is undoubtedly one of the strengths of the scientific collaboration between Italy and China.

- ***Scientific Publications***

Transnational research networks are becoming increasingly complex. Given the leading role China has recently acquired in international science, collaboration on scientific publication with China is becoming increasingly significant also in terms of quality of research.[24]

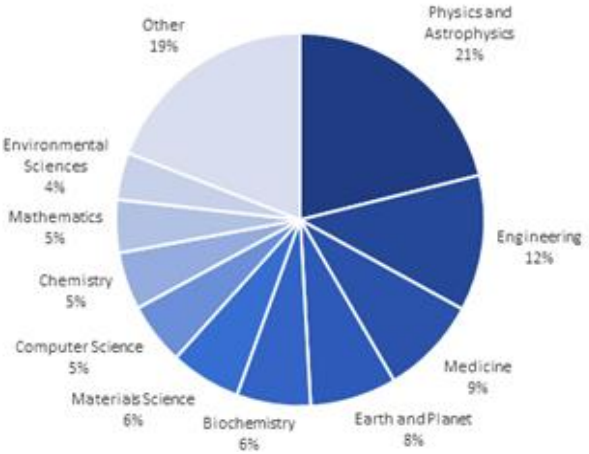
During 2019, 3066 joint scientific publications were published by Italian and Chinese scholars (**Figure 1**). The analysis of the composition by discipline allows to identify the fields where collaboration is most active. The main sector is that of physics and astronomy, with over 21% of total publications. These are followed by engineering, medicine and earth science. Traditionally, bilateral collaboration between the two countries is characterized by science studies precisely in the field of physics, thanks also to the long-standing collaboration between the INFN and IHEP.

The data relating to the percentage of publications by subject are also reflected in those relating to the composition of the main institutions contributing to bilateral research (**Figure 2**). In fact, these are research institutes or universities that have a strong tradition of research in basic science such as physics. The Chinese Academy of Sciences (CAS) together with La Sapienza (Università degli Studi di Roma) are the two institutions giving the greatest contribution to the overall number of joint publications. It is important to note that these publications also feature the presence of authors from other countries, mainly the United States and the European Union. Another important fact to underline is the size of the institution. On the Italian side, La Sapienza, Alma Mater Studiorum Università di Bologna, Università degli Studi di Padova and Università di Pisa are the research universities involved in collaborations with large Chinese institutions such as CAS, IHEP and Tsinghua University, being similar in terms of size and number of researchers.

Scientific collaboration between the two countries has experienced exponential growth since 2010, (**Figure 3**). This trend testifies to the growing degree of scientific cooperation between the two countries. It will be interesting to observe what the data will be for 2020, given the restrictions to the mobility of researchers due to the pandemic.

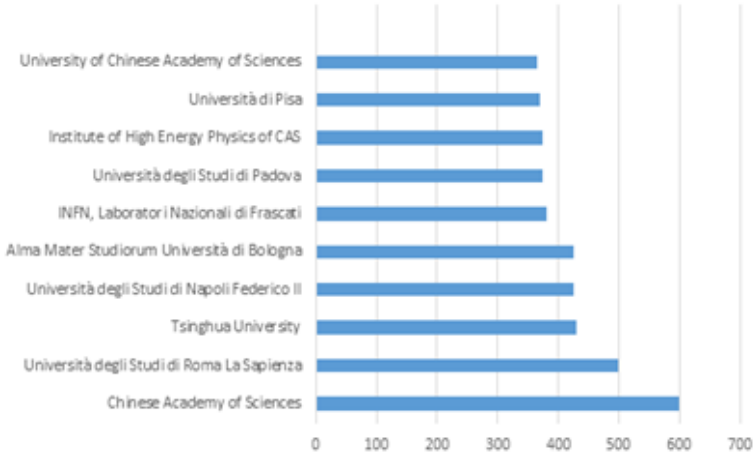
[24] Rubini, Lauretta, Chiara Pollio, and Marco R. Di Tommaso, 2017. "Transnational Research Networks in Chinese Scientific Production. An Investigation on Health-Industry Related Sectors", *International Journal of Environmental Research and Public Health* 14, no. 9: 975. https://doi.org/10.3390/ijerph14090975.

Figure 1: Percentage Composition of Italy-China Joint Publications in 2019 by subject.



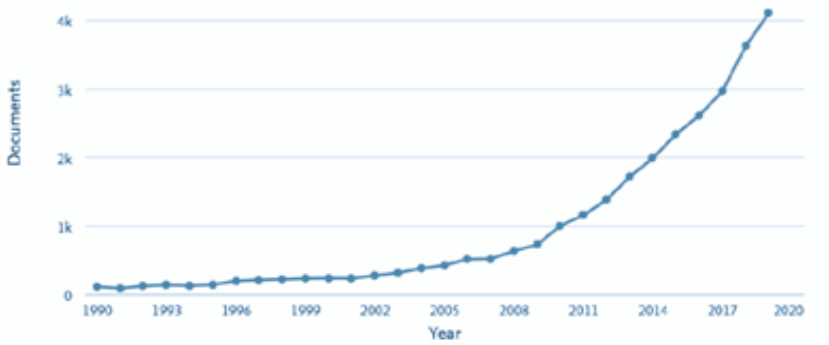
Source: Scopus data, November 2020.

Figure 2: Main Institutions contributing to bilateral research (number of joint publications)



Source: Scopus data, November 2020.

Figure 3: Trend of Italy-China scientific collaboration since 1990.



Source: Scopus data, November 2020.

2.1.7 *Initiatives for Start-ups and Innovation*

Italy[25] is among the most active European countries in promoting cooperation with China when it comes to start-ups. Since 2016, Italy and China have joined forces to foster a series of initiatives to promote collaboration on the development of innovative start-ups and SMEs.

On the occasion the Italian government's visit to Beijing, Cassa Depositi e Prestiti (CDP Group)[26] Chief Executive Officer Fabio Gallia and China Development (CDB) Bank Chairman Hu Huaibang agreed to together create a new 100 million EUR instrument that will invest in the capital of Italian and Chinese SMEs. The agreement signed on May 16, 2017,[27] represented the first step towards the co-creation of the new 100 million EUR instrument which invested in the capital of Italian and Chinese companies – preferably SMEs – with operations in Italy or China. As early as a few weeks later, members of the Italian and Chinese financial institutions started working to make the memorandum of understanding operative.

The new fund was the first of its kind to support Italian business growth in China and Chinese enterprise expansion in Italy. The agreement with China Development Bank opened a new chapter in Italian-Chinese relations, laying the foundations for long-term strategic collaboration. For the first time in Italy, in fact, work was carried out to the realization of an instrument of equal participation by important financial institutions of the two countries that enabled the Italian and Chinese SMEs to value high development prospects through direct investment in venture capital, thus providing a concrete support to the national production system and its growth abroad.

2.1.8 *Italy-China Best Startup Showcase Entrepreneurship Competition* (BSSEC)

In 2016, the Italian MEUR and MED together with the Chinese MOST launched the *Italy-China Best Startup Showcase Entrepreneurship Competition* (BSSEC), the first institutional internationalization program for Italian and Chinese innovative start-ups and SMEs. In Italy, the program is coordinated by Campania NewSteel, a certified start-ups incubator of the University of Naples Federico II and Città della Scienza, Italy Startup, PNI Cube and SPICI Srl, while the Chinese partner is the International Technology Transfer Network (ITTN). The key innovation sectors are AI and Big Data, advanced manufacturing, green innovation and sustainability, digital economy, intelligent equipment, health and biosciences. From the over 100 participants to the 2018-2019 edition, 36 Italian and 12 Chinese start-ups, and 54 innovative SMEs were selected. Before the awarding ceremony held in November 2019, the program included meetings with Chinese venture capitalists and visits to some of the most important innovation and industrialization centers in China, such as Huawei and Alibaba.

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[25] Based on the results of a search on technology-related start-ups, on the database of *Registroimprese*, in the years 2010-2021 Italy registered 9904 tech start-ups. Italy now counts a total of 13776 innovative start-ups, 178 start-up accelerators and incubators, of which 46 certified incubators, with over 1 billion euros invested in technology start-ups. When it comes to start-ups, the percentage of Italian scale-ups is just 3.2% of the European total, with just 1.6% of the total capital transferred into European scale-ups.

[26] Cassa Depositi e Prestiti is the Italian National Promotional Institution. It fosters the development of the Country, using responsibly national savings in order to support growth and boost employment, leveraging on innovations, business competitiveness, infrastructure and local development. More details are available at: https://www.cdp.it/sitointernet/en/il_gruppo_cdp.page.

[27] Former Italian Premier Paolo Gentiloni, President Xi Jinping, and CDB President Zheng Zhijie also attended the signing ceremony.

2.1.9 *China-Italy Innovation and Entrepreneurship Challenge*

Another initiative launched in 2016 was the *China-Italy Innovation and Entrepreneurship Challenge*, supported by the China-Italy Innovation Forum and coordinated by Polytechnic of Milan and PoliHub. From October 2016 to November 2017 this competition involved 20 teams from over 10 cities across Italy and China competing in the fields of smart city, smart/green building, agriculture and food safety, smart manufacturing, aerospace, clean energy technology, health and life-sciences. The ultimate goal of the challenge is to boost industrialization and product development, as well as to encourage outstanding projects to land in innovation incubators or technology parks both in Italy and China.

2.1.10 *Global Startup Program*

The *Global Startup Program* is an initiative launched in 2019 by the Italian MOFAIC, the MED, the Italian Trade Agency - ITA (ICE) and by Italia Startup. The aim of the program is to help Italian start-ups from key sectors – ICT, robotics and Industry 4.0, aerospace, automotive, life sciences, smart agriculture and foodtech, circular economy, and smart cities and domotics – to access international markets. China was among the few destination countries participating in the first edition. During the first edition of the *Global Startup Program*, out of the 92 Italian start-ups landed in China to test their ideas and technologies in the Chinese market, 12 were hosted for three months in 4 accelerators of the Shanghai Technology Innovation Center (STIC) – Caohejing Innovation Center, XNode, InnoSpace and neoBay.[28] During their stay, the 12 start-up entrepreneurs joined trainings and seminars to deepen their knowledge on the Chinese business environment, to learn how to optimize technical solutions and to create a network with Chinese investors.

2.1.11 *Italy-China Science, Technology and Innovation Alliance on Startups and Entrepreneurship*

In 2019 PNI Cube, Italia Startup, Campania Newsteel and the new innovative startup Company for Innovation, Cooperation and Internationalization (SPICI) signed the *Italy-China Science, Technology and Innovation Alliance on Startups and Entrepreneurship Agreement* with China International Innovative Technology Network and Collaboration Group Co. Ltd, one of the most important Chinese international operators[29]. The aim of the agreement is to organize a grass-root national innovation ecosystem and to boost the internationalization of Italian start-ups and SMEs in China, while attracting Chinese start-ups investments in Italy. The Alliance focuses on building innovation capacities, promoting technology transfers and the industrialization of Italian and Chinese businesses, universities and research centers by means of joint projects and agreements. The first event promoted by the Alliance was hosted in Naples on 10 July 2019 to introduce internationalization strategies and opportunities along the New Silk Road to innovative Italian and Chinese start-ups and SMEs. The Science Counsellor of the Embassy of China in Italy, Sun Chengyong, attended the event along with 15 Italian start-ups eager to enter the Chinese market. The event is an important matchmaking platform not only for researchers and entrepreneurs, but also for Italian and Chinese investors, companies, and government administrations.

[28] See for details: http://conschongqing.esteri.it/consolato_chongqing/resource/doc/2020/02/news_asc_n9__iiq_2019r.pdf.
[29] The agreement was signed in the context of an event promoted by the Italian Federation of Industry (Confindustria) and the Naples Union of Industries.

2.2 The FDI relations and domain on STI between Italy and China

The analysis and evaluation of FDI flows between Italy and China on STI is crucial for grasping and economically quantifying the broader scenario of the relations of both countries. To this regard, this section will focus on Italy-China cooperation based on FDIs mutually performed by both countries in the STI domain.

Historically, FDIs have contributed to strengthen cooperation between Italian firms and Chinese entrepreneurs after the launch of Open-Door policy. Since then, despite being smaller in size when compared to big European players, Italian FDIs have found their venue in the Chinese economy. Against this backdrop, after Chinese accession to the WTO, FDI inflows to China experienced a double-digit growth (+11% between 2000 and 2010). However, after a decade of astonishing figures for foreign investments in the PRC, FDI inflows to China decreased significantly to 2.4% between 2011 and 2018. In 2017, China experienced again a negative trend of FDI inflows, with -1.3% compared to the previous year.[30] Nevertheless, and surprisingly despite the effects of the Covid-19 pandemic on the rest of the world, China became second after the US in attracting FDI and in 2020 managed to gain the top of the podium with an amount of investments worth USD 163 billions, according to UNCTAD: +4% compared to figures for the year 2019. In fact, even if FDI flows at the global level fell by as much as 42% in just one year, China was still able to profit from the revenues of its leading industries operating in IT and e-commerce sectors.[31]

As for the diversification of FDI inflows to China, data from the Chinese Ministry of Commerce (MOFCOM) shows that in 2019,[32] FDIs to China were mainly directed to manufacturing, real estate, leasing and business services, information transmission, software and information technology services, wholesale and retailing, finance and scientific research, technology service and geological prospecting (**Figure 4**). These seven industries accounted for 89.2% of the total FDI inflows. As Figure 4 shows, STI investments were among the industries receiving the highest investments.

Table 1 shows the distribution of FDI per sector as of 2019. Out of a total of 40,910 Foreign-Invested Enterprises (FIEs) in China, 9,478 of them operate in STI sectors – 10.5% in Information transmission, Software and Information Technology Services, and 12.67% in Scientific Research, Technology Service and Geological Prospecting. Such sectors accounted for 18.3% of total realized FDI value in aggregate terms. As reported by the Italy-China Foundation, and confirmed by the 2020 Statistical Bulletin of FDI in China, aggregate European FDIs in China are only second to those of Asian countries. The pool of main investors in China remained stable across time and the magnitude of their investment flows even came to increase in recent years, especially when it comes to European countries such as the Netherlands (+47.6%) and the United Kingdom (+30.7%). If FDI stocks are considered instead of flows, through the years since its opening-up, China has accumulated a total of USD 1.918 billions, positioning itself as the third global recipient of foreign investments after the United States and the United Kingdom.[33]

[30] World Bank Data, Foreign Direct Investment, net inflows (% of GDP) - China. Available at: https://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZS?end=2019&locations=CN&start=2000.
[31] See for details: https://unctad.org/news/global-foreign-direct-investment-fell-42-2020-outlook-remains-weak.
[32] For the full report, see http://images.mofcom.gov.cn/wzs/202012/20201230152644144.pdf.
[33] XII Annual Report, Italy-China Foundation, 2021, available at: https://www.fondazioneitaliacina.it/m/cesif/rapporto-annuale/2019/.

2.2.1 *The Italian Realm: FDI flows to China on STI*

As for Italy's FDI to China, by looking at the data on the yearly flows of FDI for the period 2013-2019, the trend in investments oscillates with ups and downs across years, in line with incoming flows from other EU-28 countries. The first outstanding result for the period displays a dramatic loss for Italian investors in 2014, followed by a quick recovery in 2015 with an Italian FDI flow of EUR 485 million (**Figure 5**). In 2016, Italian FDI to China totaled EUR 201.4 million (USD 223 million), while other EU countries, such as the UK, Germany and France invested EUR 1.22 billion (USD 1.35 million), EUR 2.45 billion (USD 2.71 billion) and EUR 786 million (USD 870 million) respectively.[34] Data from the Italian Trade Agency show that in the first three trimesters (January to September) of 2017, Italian FDIs to China reached EUR 153 million (USD 173 million), while Germany, France and the UK displayed significantly higher FDI flows in the same period: EUR 1,23 billion (USD 1.39 billion), EUR 553 million (USD 625 million) and EUR 628.5 (USD 710 million) respectively. The total amount of Italian FDIs in China for the year 2017 reached around EUR 566.5 million (USD 640 million).

In 2018 Italian FDIs in China experienced a dramatic increase reaching an amount of EUR 1.34 billion for that year only, just before the signing of the MoU between the two countries the following year. The most recent available data assessing the presence of Italian investors in China is dated 2019. Data from the *XII Annual Report* by the Italy-China Foundation display the presence of as many as 1700 companies participated by Italian groups in Mainland China, employing about 170.000 workers and with a profit of EUR 27.5 billion for that year only. The *XII Annual Report* also takes into account companies based in Hong Kong relying on Italian capital, which add 500 units, 20.000 more jobs and a business net worth EUR 9.5 billion to the already existing figure.[35] These figures confirm how the financial district still plays an important role as an access gate for foreign investors to the Chinese continent and vice-versa.

Statistical data produced by the Chinese MOFCOM show that, over the years up until 2019, Italian FDI in China totaled EUR 6.7 billion (USD 7.5 billion), 0.5% of the total FDI inflows to China, with participation in a total of 6388 enterprises established in China. In 2019 alone, Italian FDI in China totaled EUR 159 million (USD 190 million).[36] The outstanding discrepancy in the number of Chinese companies participated by Italian investors, as provided by the *XII Annual Report* and the Chinese MOFCOM, is explained by the two different minimum participation thresholds employed by the two institutions. While MOFCOM takes into account all participated companies present on the Chinese territory, data from the *XII Annual Report* rely on statistics provided by ISTAT, which do not factor enterprises with less than 50% of Italian participation in the firms' total capital. Both reference values show that the trend seems to be growing, at least if compared to the year 2018, which accounted for a presence of 1600 Italian companies circa, with a turnover and a number of employees proportionally smaller to the values for the year 2019.

Along with the global and especially European trends, after China's access to the WTO in 2001, it is possible to affirm that Italy has nearly doubled its presence as an investor in China in the past twenty years. Overall, despite the decreasing trend in proportion to China's GDP, FDIs are still a fundamental source of growth for the country's economy.[37]

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[34] The comparison is made based on the data produced by China's National Bureau of Statistics, as reported by the Italian Trade Agency. For more details, see: https://www.ice.it/it/sites/default/files/inline-files/83%20Scheda%20paese%20Cina%20-%20agg.25%20maggio%202018.pdf.
[35] XII Annual Report, Italy-China Foundation, 2021.
[36] MOFCOM, Statistical Bulletin of FDI in China, 2020.
[37] XII Annual Report, Italy-China Foundation, 2021.

Italian FDI to China, 83% of which coming from Northern Italy regions, changed throughout the years not only in their economic value, but also in their structure and targeted sectors.[38] Before China entered the WTO and started to undertake its evolution from factory of the world to innovator in tech-related sectors, Italian as much as other foreign FDI were mainly directed to low-cost and labor-intensive production. With the new millennium though, Italian investors diversified their portfolio in areas ranging from the production of electronic devices to the energy sector, constructions and manufacturing of goods in metal, plastic and rubber.

As happened for FDI moving in the opposite direction, namely from China to Italy, the total number of investments decreased, but a significant number of those which persisted, augmented in both importance and magnitude. By looking at the sectoral distribution of investments, data for the year 2020 show a +11% increase of foreign FDI flows going to high-tech sectors, especially ICT.[39] As shown by the pie-chart in **Figure 6**, the structure of Italian investors' participation in China is sufficiently diversified across the different industries of the Chinese economy, with the majority of players to be found in the field of Wholesale and Retail (43%), Agriculture and Mining (13%), Machinery and Mechanical Appliances (11%), Electric Products and Electronic (8%). It is also interesting to note that the share of actors investing in these high-tech and added-value industries is quite outstanding when compared to the share of those investing in low-production cost and low-return industrial sectors.

In the following section, data retrieved from the *XII Annual Report* by the Italy-China Foundation illustrates some evidence of Italian investments in China.[40]

Despite Italian FDIs being mainly directed to electric and electronic goods, the automotive sector has been the one offering the majority of opportunities for Italian FDI so far. In 2015, the Fiat Chrysler Automobiles (FCA) group launched the production of Jeep Cherokee and Renegade in China. In 2016 Brembo, world leader in the production of braking systems, acquired 66% shares at a value of 86 millions EUR of Asimco Meilian Braking Systems and opened a new plant in Nanjing in 2019 through an investment of 100 million EUR and offering employment to 450 workers. However, the uncertainty affecting the automotive sector at the global level has been influencing China too: the selling of new vehicles contracted for the first time in 2017-2018, peaking at -3.11%, a loss which affected the first trimester of 2019 too. The Chinese automotive market seems however to be a long way from being saturated, both because of the low household/car ownership ratio – which in 2019 nationwide was 35.3 cars per 100 households – and the ongoing changes in a sector transitioning to green and smart vehicles. Such evidence seems to suggest that the sector is still able to offer collaboration and investment opportunities for Italian industries.[41]

Prysmian Group, specialized in the manufacturing of cables used in sectors such energy, telecommunications and optical fiber opened a new plant in Jiangsu in 2017, after acquiring assets from Shen Huan Cable Technologies. The plant is among those with highest production held by the group, with a capacity of 30.000 tons per year. In 2021 Prysmian furtherly increased its presence in the industry in China by acquiring EHC Global.

The Chinese energy sector provides important opportunities for foreign investors too, given the urgent need for China to modify the qualitative structure of its energetic mix in order to meet its CO2 reduction target and shift from coal-burning to natural gas and other green energy solutions for electricity

[38] Ibidem.

[39] See for details: https://unctad.org/news/global-foreign-direct-investment-fell-42-2020-outlook-remains-weak.

[40] XII Annual Report, Italy-China Foundation, 2021.

[41] See for more details: https://www.statista.com/statistics/233678/number-of-cars-per-100-households-in-china-by-income/.

production. In this regard ENI, already present in China since 2012, signed an agreement with Zhejiang Energy. In 2019 ENI signed another agreement with Bank of China in order to get financial support to cooperate with both China National Offshore Oil Corporation and PetroChina to provide infrastructure for the extraction of both oil and natural gas.[42]

Previously, in 2018, Ansaldo Energia announced a few agreements for technology collaboration in the field of heavy duty gas turbines, first with Shanghai Electric and Benxi Steel and then with China United Gas Turbine Company. Followed in 2019 by SNAM, which signed a MoU with the Silk Road Fund to cooperate in the construction of natural gas infrastructure, such as pipelines, storage facilities, LNG infrastructure and biomethane plants.[43]

When it comes to the transportation sector, in 2018 Leonardo, an active player in fields such as electronics, security and aerospace, signed a MoU with Kangde Investment in order to increase its presence in China through the project Comac CR929. The collaboration, which goes under the name of Kangde Marco Polo Aerostructures Jiangsu Co. Ltd., aims at building a new prototype of civil transportation jet to be built in a new plant in China and delivered by 2025.[44]

Previously, in 2017, Fincantieri signed an agreement with the China State Shipbuilding Corporation (CSSC) and the Baoshan district, home of China's biggest commercial and cruise port. The idea was to create a park for the shipbuilding industry, in which Italian suppliers of Fincantieri could find new market opportunities in China too and contribute in developing the country's cruise sector.

ENEL (Italy's former State-Owned National Agency for Electric Power) is particularly active in China, especially considering the extent and variety of fields in which it operates. Through its global business line Enel X, the energy giant started offering the products it developed as innovative and digital solutions for sectors such as urban, industrial and electric transportation – a field in which China is particularly active especially in its biggest cities. Enel X has entered the market through its Juice Boxes, the charger points for electric vehicles specifically developed for households. In 2020 Enel X signed an agreement with Shanghai-based Weltmeister, producer of electric vehicles. The aim is to support the Chinese company to develop its charging infrastructure both at the domestic and at the global level, in Europe and South-East Asia especially.

Despite the plethora of foreign investors present in China, there are still a number of difficulties faced by Italian as well as other foreign firms when trying to enter the market. The first step before deciding whether to invest in China or not is for foreign investors to consult the *Catalogue for the Guidance of Foreign Investment Industries*[45] in order to verify that the investment they are willing to make is allowed in their targeted sector. Foreign investors are denied access to sectors on the *Negative List*, namely those in which their presence and interference may threaten national security, procure damage to natural resources and cause environmental pollution, among others. The Catalogue, however, provides also indications regarding sectors where FDI is particularly welcomed and customs procedures simplified, these include: technologies for energy and natural resources saving, technology for development of agriculture and in general all those necessary to promote social and economic development in China.

[42] See for more details: https://www.eni.com/it-IT/scenari-energetici/unione-economica-eurasiatica.html.

[43] See for more details: https://www.huffingtonpost.it/2019/03/22/italia-cina-ansaldo-eni-snam-atlantia-cdp-dieci-accordi-firmati-dalle-aziende-italiane-e-19-patti-istituzionali_a_23698648/.

[44] See for more details: https://www.leonardocompany.com/it/press-release-detail/-/detail/comac-cr929.

[45] The full list of 2020 Catalogue edition available in Chinese at: http://english.mofcom.gov.cn/aarticle/policyrelease/gazette/200505/20050500093692.html.

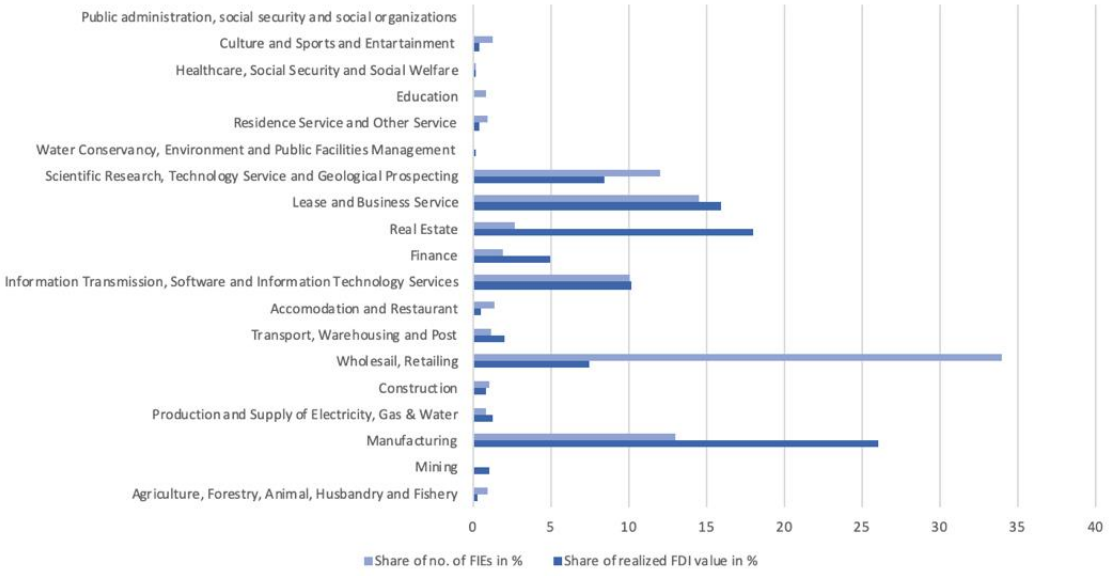
There also exist barriers not specifically related to China's domestic regulations, rather to how the country is perceived abroad. Corruption has been identified as an obstacle, especially when it results in unproductive and low-quality investments. But President Xi has made the fight against it one of the trademarks since his accession to power in 2013. Cultural differences represent a further obstacle, requiring an effort in formation of personnel and change in managerial practices to be performed. This aspect can be linked to the importance of developing *guanxi,* a particularly important feature characterizing business in China where a network of relations is built, several times supporting companies to overcome bureaucratic issues.

An obstacle for Italian investors is also the availability of financial resources: Italy's economy is represented mainly by SMEs often limited in their endowments, whereby a high availability of capital is necessary to enter a market as big as the Chinese. The violation of intellectual property, finally, has historically been perceived as a threat for foreigners willing to set up operations in the high-tech industry in China or collaborate with local partners. Recognizing the importance of attracting FDI and the role they have played so far in helping China's economic growth, the PRC government has recently taken initiative in addressing some of the concerns of foreign investors. On March 15th, 2019 the *Foreign Investment Law* (FIL) was approved and entered into action on January 1st 2020.[46] The new regulation came as a substitute of the previous three laws that governed FDI in China: the *Chinese-Foreign Equity Joint Ventures Law* (1979), the *Wholly Foreign-Owned Enterprises Law* (1986) and the *Chinese-Foreign Contractual Joint Ventures Law* (1988). The new law specifically prohibits the government and government officials from forcing transfer of technology and it gives the possibility to foreign investors to receive the same treatment when they apply for licenses and participate in public procurement, among other concessions. Jointly with the promulgation of the FIL, Chinese authorities updated the *Catalogue of Encouraged Industries for Foreign Investment*,[47] thus lengthening the list of sectors in which FDI is welcome. The latter gives special attention in fostering economic and social development in provinces of Western China, characterized by industrial backwardness when compared to the much wealthier coastal areas and their higher living standards.

Several analysts also pointed out that the two initiatives will have an extremely beneficial effect in fostering FDI in China in the next decade.[48]

[46] MOFCOM, http://mg.mofcom.gov.cn/article/ddfg/201912/20191202924661.shtml.
[47] Part 1 of the 2020 Catalogue.
[48] See for example:
1. https://www.bakermckenzie.com/en/insight/publications/2021/01/china-enacts-new-foreign-investment-security;
2. https://brill.com/view/journals/jwit/22/3/article-p388_3.xml;

Figure 4: Industrial Structure of total FDI inflows to China in 2019.



Source: *Author's own elaboration using data from the X Annual Report*, Italy-China Foundation, 2019.

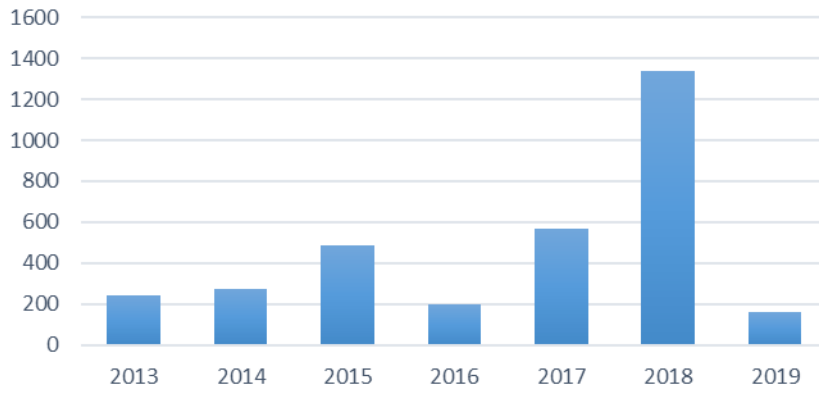
Table 1: Reference Data on FDI Distribution in Major Sectors in 2019, Unit: USD 100 million.

Industry	*No. of FIEs*	*Growth Rate %*	*Realized FDI Value*	*Growth Rate %*
Mining	*31*	*0.1*	*21.9*	*1.6*
Manufacturing	*5396*	*13.2*	*353.7*	*25.0*
Production and Supply of Electricity, Gas & Water	*295*	*0.7*	*35.2*	*2.5*
Construction	*557*	*1.4*	*12.2*	*0.9*
Transport, Warehousing and Post	*591*	*1.4*	*45.3*	*3.2*
Information Transmission, Software and Information Technology Services	*4295*	*0.5*	*146.8*	*10.4*
Finance	*887*	*2.2*	*102.2*	*7.2*
Scientific Research, Technology Service and Geological Prospecting	*5183*	*12.7*	*111.7*	*7.9*
Water Conservancy, Environment, Public Facilities Management	*143*	*0.3*	*5.2*	*0.4*

Source: *Author's own elaboration on 2020 Statistical Bulletin of FDI in China.* [49]

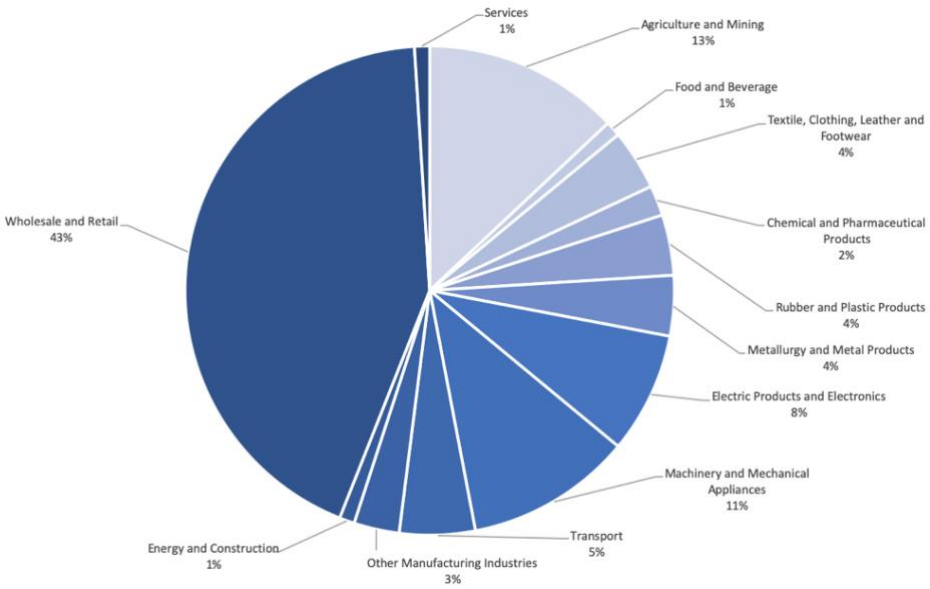
[49] http://images.mofcom.gov.cn/wzs/202012/20201230152644144.pdf.

Figure 5: FDI flows from Italy to China from 2013 to 2019 in million EUR.



Source Author's own elaboration on data from Statista, XII Annual Report, Italy-China Foundation, 2021 and 2020 Statistical Bulletin of FDI in China (MOFCOM).

Figure 6: Breakdown of Italian-owned companies in China by sector of activity, 2019.



Source: Author's own elaboration using data from the XII Annual Report, Italy-China Foundation, 2021.

2.2.2 The Chinese Realm: FDI flows to Italy on STI

The collaboration between China and Italy in developing a common framework for science, research and innovation is not limited to the institutional realm described in the previous sections of this work. The two countries have committed themselves to the effort of boosting industrial competitiveness by jointly investing in R&D and the use of new technologies. Should Italy and China be able to capitalize on the synergies between *Made in China 2025* and the Italian *Industry 4.0* industrial modernization plan, they might as well be able to overcome internal structural issues such unemployment, unequal regional development and boost economic growth.

In 2018, in Milan the two countries held the "China-Italy Science, Technology & Innovation Week", the annual matching event, alternately organized in Italy and China, which brings together in a single format, according to the back-to-back formula, the China-Italy Innovation Forum and the Sino-Italian Exchange Event. Here Italian and Chinese operators have the opportunity to exchange information, present their technologies, take part in B2B meetings with the aim of strengthening cooperation and business opportunities and to promote joint projects"[50]. At this occasion 19 cooperation agreements in research and economy were signed. In the course of the event, several statements were made by both the Italian Minister of Education and Research Marco Bussetti and the Chinese Minister of Science and Technology Wang Zhigang. Taking into consideration the governmental declarations of both sides during the event in Milan, it is possible to analyze how the cooperation between the two powers moves from the institutional to the economic domain in building a joint Sino-Chinese STI realm. Minister Bussetti affirmed that "The knowledge economy goes beyond national borders ... and it is therefore only by enhancing research that we can plan a future of individual and collective prosperity".[51] A fundamental strategy to make such 'knowledge economy' move is doing so through FDIs, the direction of the movement seems to follow what was declared in Milan by the Chinese counterpart Wang: "Italian research is internationally renowned, and we will keep working together on pilot projects in many sectors, from aerospace to intelligent manufacturing. Particular attention will be paid to sustainable energies"[52].

Before analyzing in depth the structure of technology related FDI from China to Italy, it is important to look at the general trend in Chinese investments in the Mediterranean country in the last decade. By the end of 2020 a total of 320 Chinese business groups were present in Italy, participating in the activities of as many as 620 Italian enterprises employing about 31.100 workers and with a turnover worth EUR 19 billion (ref. 2019). If Hong Kong is included, the number of participated Italian companies increases up to a total of 906, with a business net worth EUR 28 billion. Data for the 2013-2019 period display an impressive decline in incoming FDI flows, which shrunk from EUR 3.3 billion to only EUR 63 million in 2019 (**Figure 7**). It needs however to be highlighted that the sharp decrease in investments in Italy is in line with the status quo of Chinese FDIs to European countries in the same period. In 2020, Chinese FDIs in Europe accounted for only EUR 6.5 billion, almost half of the amount displayed for the previous year. This dramatic decline comes as the outcome of both the Covid-19 pandemic and changing domestic environment in both China and the EU-28. On its side, the Chinese government strengthened its grip on the domestic economy through financial and administrative limitations which made it harder for domestic firms to get endorsement for their will to expand operations overseas. A tighter regulatory environment has been set in Europe too on incoming FDI, providing an additive push in furtherly

[50] http://www.cittadellascienza.it/international-activities/china-italy-science-technology-innovation-program/?lang=en.
[51] See for details: http://www.xinhuanet.com/english/europe/2018-12/05/c_137652319.htm.
[52] Ibidem.

decreasing the magnitude of Chinese investments in the European Union. Despite being significantly minor in their proportion when compared to the beginning of the 2010s, it can be said that Chinese investments in Italy have become more strategically targeted towards sectors which might have the capacity to be mutually productive in terms of impact and future returns for both the players involved. Building on the legacy of the document published by MAECI in 2015 *Scienza & Tecnologia – Per una Strategia Italiana In Cina* and followed in 2020 by *ITALIA – CINA | Collaborazione Scientifica e Tecnologica Piano d'Azione verso il 2025*, to whom China responded in 2017 with the *Action Plan for the strengthening of economic, commercial, cultural and scientific-technological cooperation between Italy and China 2017-2020*, the two countries have intensified the collaboration at industrial level in the STI sector. The Action Plan furtherly strengthened the content of the PRC's 13th FYP (2016-2020), aiming among other things at implementing new strategies to boost economic development during the slowdown represented by the New Normal era in China.

Priority sectors for the joint industrial cooperation in cutting-edge technologies are represented by new and advanced materials and nanotechnologies. China is a world leader when it comes to such fields and it has been able to recognize Italy's strong potential in the very same fields when compared to other European players. By cooperating in China, Italian private and public companies operating in such areas would gain access to sophisticated technologies and know-how, thus strengthening the quality of their own products and developing a long-term strategy of industrial leading. Transportation, especially if non-CO2 emitting, along with investments in the energy sectors are additional fields of strong interest, especially in the light of the Paris Agreement and its targets ratified by both China and Italy. Last, but not less important, are the investments by ICT sector giants with opportunities identified in AI, Big Data and IoT for smart manufacturing. By looking at the data from the MOFCOM[53] on Chinese FDI to Italy divided by sectors for the period 2011-2019, there exists a correlation between Wang's statements at the 2018 China-Italy innovation week and the actual status of investments. Energy, technology and transport are the only outstanding sectors when it comes to the magnitude of investments performed in Italy by Chinese companies. In 2020, the Italian Manufacturing sector alone attracted 25% of total Chinese investments, followed by another 18% in construction and utilities. When considering the regional distribution of FDI flows, 77% out of the total were focused in Northern Italy, with about half in Lombardy alone (**Figure 8**).
The existing data provide the following information regarding the amount of FDI:

- **Energy** sector: total of EUR 5.66 billion (USD 6.28 billion) reported for the years 2014-2015;
- **Finance** sector: only significant outlier attracting as much as EUR 2.53 billion (USD 2.81 billion) in investments in the years 2014-2015;
- **Technology** sector: EUR 3.42 billion (USD 4.32 billion) with investments spread across the 2011-2019 period and displaying remarkable peaks in the years 2013, 2016 and 2019;
- **Transport** sector: EUR 7.81 billion (USD 8.75 billion), with the majority of investments performed in 2015.

Also available for the very same 2011-2019 period are specific details on FDI from China to Italy for the technology-related operations in various sectors in terms of the companies involved, the actual sector in which they operate and the magnitude of the investments performed. Below we proceed again in breaking down data by highlighting the truly relevant FDIs in terms of quantity:

[53] The Database elaborated by UCAS covers both greenfield and non-greenfield (e. g., M&A, joint venture) investments.

- 2013:
  - Huawei invested EUR 977 million (USD 1.3 billion) in VimpelCom, operating in the technology sector;
- 2014:
  - State Administration of Foreign Exchange (SAFE) invested EUR 2.08 billion (USD 2.76 billion) in Eni and Enel, giants on the Italian market operating in the energy sector;
  - Another FDI in the energy sector performed by State Grid towards CDP Reti with a value of EUR 2.08 billion (USD 2.76 billion);
  - SAFE invested EUR 391 million (USD 520 million) in Telecom Italia;
  - Shanghai Electric invested EUR 421 million (USD 560 million) in Ansaldo Energia

- 2015:
  - SAFE in partnership with ChemChina performed a EUR 7.08 billion (USD 7.86 billion) investment in Pirelli operating, in the transport sector;
  - SAFE invested EUR 1.1 billion (USD 1.22 billion) in Intesa Sanpaolo and another EUR 739 million (USD 820 million) in Unicredit, both operating in the finance sector;
  - Sinochem invested EUR 6.58 billion (USD 7.6 billion) in Pirelli;
- 2016:
  - ZTE performed a EUR 910 million (USD 1.01 billion-worth) FDI in telecommunications sector;
  - MIDEA operated an investment worth EUR 4.5 billion (USD 4.99 billion) in Clivet, operating in the electric appliances sector;
- 2018:
  - the Hebei Sari V-Capital acquired the NMS group, specialized in oncological research;
  - Alibaba, leading a wider network of Chinese players, acquired the Esaote group, specialized in the biomedical sector;
  - Haier invested EUR 466 million (USD 550 million) in Candy;
- 2019:
  - Huawei EUR 1.12 billion (USD 1.25 billion) in telecommunications + another EUR 8.93 million (USD 10 million) in technology;
  - Baomarc EUR 19.5 million (USD 21.8 million) in Honeywell;
  - Sichuan Gloport Investment Group EUR 67.9 (USD 76 million) in Meta System;
  - Xi'An West Measurement Electronic Technology Service Co. Ltd. invested an unknown amount in Eles Spa;
- 2020:
  - ChemChina announced it will acquire the control of Valagro, a group operating in biotech sector and on top of 13 controlled sub-companies with 700 employees worldwide;
- 2021:
  - In May, China FAW Group Corporation announced its joint venture with the American Silk EV and the building of a plant in Gavassa, Reggio Emilia (Italy) to build high-end electric carsShangha. The investment is predicted to be worth about EUR 840 million (USD 1 billion) and provide roughly 1000 new employment opportunities in the area.

Other outstanding investments involving the acquisition of shares in an Italian company by a Chinese counterpart have been performed previously in 2014 in favor of F.C.A., Telecom Italia, Generali and Terna. Followed in 2015 by investments in the manufacturing sector: the China National Chemical Corporation acquired 26% of shares in Pirelli and China State Grid acquired some 35% of shares in CDP Reti.

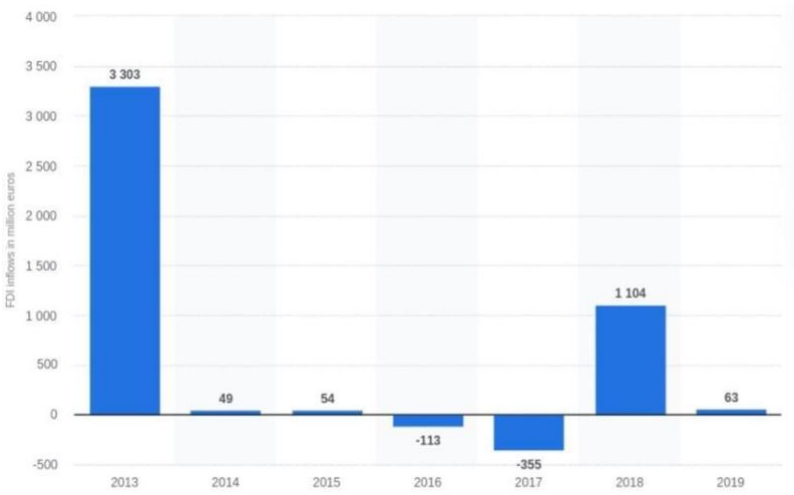
After analyzing the data on FDI, there are some considerations to be made pertaining both to the nature of these investments and their possible broader implications. After 2014 (included) all investments are performed under the BRI framework, launched by President Xi Jinping the previous year. In the pre-2015 period SAFE is the entity performing the majority of investments, both in number and in magnitude, despite operating none after that year to give space to a more diversified situation in terms of actors involved. This is consistent with a change in the Chinese domestic environment, whereby the government has decided to let private companies become leaders in OFDI instead of State-Owned ones. Data for State-Owned enterprises show that historically they have performed the largest share of investments in Europe in general, with a peak of 70% in the 2010-2015 period. Tighter regulations imposed in 2018 in China on FDI had a profound impact in shifting the situation in favor of private firms, despite impacting on them too.

One final consideration worth-doing is that only very few operations we have data about are greenfield investments. In fact, these types of investments are performed mainly when it comes to set-up firms in low-skilled sectors. In order to perform a quick catch-up in highly knowledge-intensive sectors, Chinese investors are interested in acquiring shares in enterprises already well-established on the market and able to provide knowledge spillover.[54] Considering the definition of greenfield investment, there are some implications coming with their low quantity in Italy in technology-related sectors, where Chinese companies prefer entering into business by acquiring already existing assets. A greenfield investment gives to the parent company (based in China, in this case) the highest degree of control and it is usually performed in developing countries where it becomes easy to take advantage of a favorable tax treatment for foreign companies operating inside the borders of the hypothetical developing country. Italy, however, is a developed and industrialized economy, a characteristic apparently consistent with such findings. It is also true though, that greenfield investments are usually not performed in politically unstable countries. This becomes especially true in China's case, whose government strongly prefers cooperation with politically and socially stable environments: investing in Italy in projects to be built from the ground might be perceived as too much risk-bearing. Italy, in fact, is affected by a number of structural problems which lessen its appeal as a receptor of FDIs. The public sector is very large compared to the size of the Italian economy, where the private sector is dominated by SMEs. The infrastructure to build onto is poorly developed and the bureaucracy to get projects approved involves slow and expensive procedures. Lastly, organized criminal activity highly involved in all kinds of business in some Italian regions contributes to Italy's low appeal and scarce competitiveness in attracting foreign business.

The trend, in fact, is in slight contrast with what has been happening in the EU-28 in the last five years. In 2016, greenfield investments corresponded to 20% of total Chinese FDI in the region, nearly triplicating figures for early-2000s. Biggest investors are tech-brands such as Huawei, Lenovo and ByteDance.

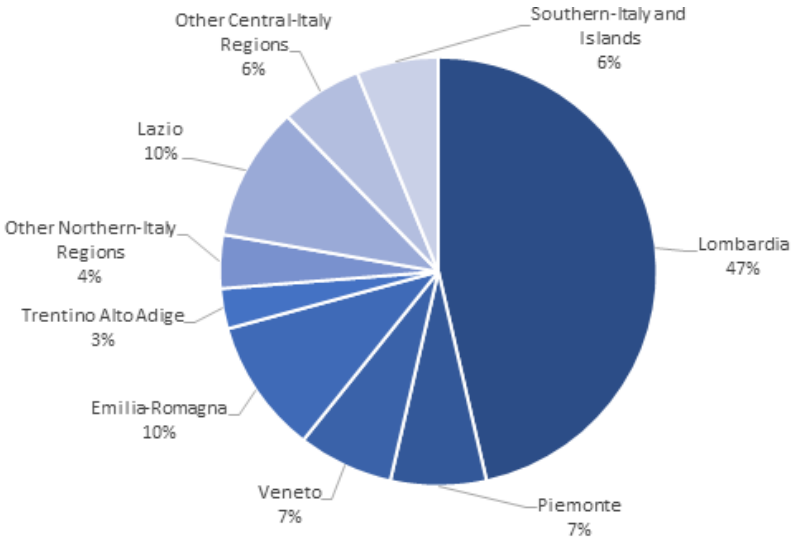
[54] Outliers performing greenfield investment in high-knowledge have been Huawei in 2011 and China Ocean Shipping in 2016, both with investments negligible in quantity.

Figure 7: FDI flows from China to Italy from 2013 to 2019.



Source: Statista. [55]

Figure 8: Regional distribution of Italian companies owned by Chinese investors, 2020.



Source: XII Annual Report, Italy-China Foundation, 2021.[56]

Table 3: Main Chinese acquisitions in Italy from 2018-2020.

Year	Investor	Value in mln	Share %	Counterpart	Sector
2018	*Invista*	*50 mln EUR*	*/*	*Aquafil Spa*	*Manufacturing*
2018	*H&T Intelligent Control International Co Ltd*	*7.7 mln EUR*	*55*	*NPE Srl*	*Technology*
2018	*Chinese Consortium*	*300 mln EUR*	*100*	*Esaote*	*Technology*

[55] https://www.statista.com/statistics/954764/inward-fdi-flows-from-china-to-italy/.
[56] The full report is available here: https://www.fondazioneitaliacina.it/m/la-fondazione/area-news/fondazione/2021/07/1009/.

2018	Qingdao Haier	550 mln USD	100	Candy	Manufacturing
2018	China Glass Holdings	21.4 mln EUR	100	Olivotto Glass Technology	Manufacturing
2018	Zhongneng Vehicle Group	10 mln EUR	100	Moto Morini	Manufacturing
2019	Zhejiang Hailiang Co Ltd	119 mln EUR	100	Intek Group Spa	Metallurgy
2019	CCCC	/	/	Genoa Port	Transportation
2019	DeepBlue Technology	/	100	/	Technology
2019	Jiangsu CAS-IGBT Technology Co Ltd	112.8 mln USD	100	LFoundry	Technology
2019	ZTE Corporation	20 mln EUR	100	Cybersecurity Lab	Technology
2019	Shanghai M&G Stationery Inc	/	15	Carioca	Manufacturing
2019	China Merchants Group	/	/	China Merchants Industry Technology-Europe (CMIT Europe)	Transportation
2019	Fosun	30 mln EUR	75	Tenax Capital	Finance
2019	Ningbo Qijing Holding	/	100	Tenova Spa	Technology
2019	Baomarc	21.8 mln EUR	100	Honeywell	Siderurgy
2019	Qianzhan Investment Management	/	/	Genenta Science	Research
2019	Dingsheng Industry Co Ltd	7 mln EUR	100	Comital Srl	Metallurgy
2019	Dingsheng Industry Co Ltd	7 mln EUR	100	Lamalù Spa	Metallurgy
2019	Sichuan Gloport Investment Group	76 mln EUR	34.5	Meta System	Electronics
2019	Xi'An West Masurement Electronic Technology Service Co Ltd	/	/	Eles Spa	Technology
2019	Cosco Shipping Ports	/	/	Yilport	Transportation
2019	Huawei	10 mln USD	/	/	Technology
2020	FAW	1 bn EUR	/	/	Automotive

Source: Author's elaboration on data from XII Annual Report, Italy-China Foundation, 2021.

3 Case study: Italy and China partnership in Environmental Protection and Green Industries

The analysis performed throughout this report has focused hitherto on the achievements of the Sino-Italian cooperation in the STI realm, both at the institutional and business level. Below, a peculiar case study regarding one of the goals such partnership aims to achieve, i.e. the environmental protection and cooperation between both countries in the green sector.

3.1 Environmental Protection Market in China

After 20 years of full steam development, China entered the new millennium with such an amount of pollution to rise an ever growing social alarm and concern, due to its impact on people's health, pushed also by such a severe air pollution that, in many major cities, the sky was screened by a permanent layer of smog for most part of the year.
With the implementation of the 11th FYP (2005-2010), the Communist Party of China (CPC) emphasized the importance of setting a new course, introducing a new radical vision incorporating environmental protection into the concept of development, under the name of "Ecological Civilization".
The turning point has been the 12th FYP (2011-2015), laid down by President Hu Jintao and inherited by President Xi Jinping, with an impressive amount of structural reforms:

- *Air Pollution Action Plan* (2013);
- *New Environmental Protection Law* (January 2015);
- *Water Pollution Action Plan* (March 2015);
- Reform of Concessions and Public Utilities, with opening to Public-Private Partnership (June 2015);
- *Integrated Reform Plan for Promoting Ecological Progress* (September 2015);
- Guidelines for issuance of Green Bonds (December 2015, People Bank of China and NDRC);

This set of structural reforms were intended to tackle environmental pollution and enforce ecological protection with a pincer movement, by raising a way more stringent regulation and setting market mechanisms, in order to transform environmental protection into a business opportunity, actively involve the population and the companies and attract both industrial and financial private investors.
In 2015, the Green Finance Committee of People Bank of China, clearly stated[57] that, to face the huge amount of expected investments for environmental protection and green transition (at least an annual investment of RMB 2 trillion - USD 320 billion), public funds could only contribute 10% to 15% of the required financial need: the private sector was expected to be the largest source of capital, contributing 85% to 90%.
Three are the pillars of the overall reform:

1. pushing companies to invest in environmental protection compliance, including decarbonisation,

[57] "Roadmap for China: green bond guidelines for the next stage of market growth", April 2016, Climate Bonds Initiative and the International Institute for Sustainable Development (IISD).

2. opening Environmental Protection to private investors through Public-Private-Partnership and establishing market mechanisms,
3. establishing a financial leverage through the emission of Green Bonds.

The 13th FYP was expected to favour the booming of the environmental protection market, led by a wave of investments, but the results did not match expectations.
The Chinese Government Expenditure on Environmental Protection as a percentage of GDP clearly achieved its peak during the 12th FYP, growing closer to the values of the European Union, but wavered during the 13th FYP (**Figure 10**).
Also the Investments performed for the treatment of industrial pollution as a percentage of total industrial investments achieved its peak in the middle of the 12th FYP, but then it decreased below the level at the end of the 11th FYP, with values 10 times lower than those of Germany and Italy (**Figure 11**).
At the end of the 12th FYP, the Chinese Government, well aware of the complexity that 'a continent-size' country requires for a comprehensive ecological and environmental protection, was in need to establish a Governance mechanism that was worthy of the challenge.
The 13th FYP focused on tightening the regulation and in reforming the administrative processes as a comprehensive mechanism under the guidance of the Government and the *Command & Control* policy, in a delicate process to push the local Governments in adhering to the national model without prejudice of the local autonomies, while the market mechanisms were left as defined during the 12th FYP.
As a matter of fact, the environmental protection market lost its momentum, mainly for two reasons:

1. The reform of the Public Concessions and Public-Private-Partnership did not work as expected;
2. Green bonds matched a tepid demand and, not being aligned to international definitions (such as Climate Bonds Initiative), the Chinese green bonds ended up supporting projects related to coal and fossil fuel exploitation.

The 2015 *Reform of the Public-Private-Partnership* (PPP) opened to the private sector the possibility to invest in environmental facilities like wastewater treatment plants, combined heat and power incinerators, waste treatment, etc. The concessions related to those investments are usually 20 years long build-operate-transfer projects, long enough to attract the interests of Chinese entrepreneurs and speculators with no preparation in the field. Local Governments, in charge to define and plan the PPP projects, in order to avoid those unprepared investors, resorted mainly to State-Owned companies (either at local and central level) or listed companies. PPP projects, by their nature, require a large amount of capital investment in the initial stage, and the PPP projects cycle is long, making it difficult for the social capital to recover the cost in a short period: a typical risk of the PPP is that industrial and financial investors may incur in cash flow pressure,[58] if not distress in some cases.
In just three-four years, a huge wave of new PPP projects were concentrated into a limited number of players, causing more than a simple cash flow pressure: between 2018 and 2019, some of those State-Owned and Listed companies went under a partial corporate restructuring, among them some market leaders such as Poten Enviro[59] and Orient Landscape.[60]

[58] "Asset-Backed Securitization of Chinese PPP Projects", XIAOKUAN LI, 2019, Royal Institute of Technology, Department of real estate and construction management, Stockholm, https://www.diva-portal.org/smash/get/diva2:1335044/FULLTEXT01.pdf.
[59] https://www.reuters.com/companies/603603.SS/key-developments https://www.reuters.com/finance/stocks/603603.SS/key-developments/article/4140531.
[60] https://www.reuters.com/companies/002310.SZ/key-developments.

Moreover, the reform of the concessions and of the Public Private Partnership has been established to contain the public debt mainly of the local Governments: the State Council issued its *Opinions on Strengthening the Administration of Local Government Debt* (State Council, 2014c), banning borrowing through local government financing vehicles and capping the amount of debt local governments can take on. Debt can be raised only for non-profit public project investments; for other infrastructure projects with potential cash returns, such as public utilities and transportation, the State Council encourages the use of PPPs or project-specific bonds.

Anyway, some local Governments were able to circumvent the reform and used PPP projects to disguise debt operations, which was not registered as such. On May 2018, Nikkei Asia[61] reported about all kind of PPP (not only for Environmental Protection) "The authorities in recent months have cancelled about 2,500 PPPs, worth around RMB 2.39 trillion (USD 376 billion) in aggregate, after Beijing concluded that local governments were abusing the infrastructure financing arrangement to circumvent controls on their borrowing, adding to a worrisome growth in public debt. The halted projects represent about 18% of those in the official pipeline. […] Chinese officials began to adopt the PPP model only in 2014. In under four years, about 14,000 projects, valued at over 20 trillion yuan, had been initiated, a staggering amount even by Chinese standards. More than 60% of the companies involved are State-Owned entities, according to the analysis of a sample of 572 projects by the Ministry of Finance's China Public Private Partnerships Center. The center found that just 4% of PPP participating companies came from Hong Kong, Macau or Taiwan, with another 2% coming from other countries. The balance of participants were Chinese private companies."

From the financial point of view, China's main solution to finance cash flow of PPP projects is Green Securitisation:[62] Asset-Backed Securities (ABS) are a special kind of bonds whose income payments and hence value are derived from and collateralized (or "backed") by a specified pool of underlying assets; they are believed to be the required tool to keeping pace with scaling up of green bond issuance. Starting from 2019-2020, major State-Owned and Listed Companies engaged in PPP projects, such as China Everbright Water,[63] are issuing their first ABS.

In 2019, ABS represented 6% of the total Green Bonds.[64] China is among the 4 leading Countries in issuing Green Bonds: between 2016 and 2019, China issued Green Bonds for a total of USD 168.75 billion. The way that China defines Green Bonds is different from international standards, because it includes also exploitation of fossil-fuels and projects that are not categorized as "Green", "Social" or "Sustainable" by international investors: 36.2% of those USD 168.75 billion are compliant only with the Chinese domestic definition (**Figure 12**). China is accelerating Green Bonds issuance, between 2016 and 2019, showing steadily increasing numbers (**Figure 13**), with a leap in 2020, when it became the second issuer after France, according to the *Climate Bonds Initiative* (CBI) definition (**Figure 14**). According to CBI,[65] in 2019, 60% of China's domestic market is composed of bonds with term up to 5 years and 33% have a tenor between 5 and 10 years, the first ones are issued mainly by Financial Corporates and the second ones mainly by Non-Financial Corporates. Only 23% are issued to support projects for

[61] "China must put the 'private' into PPP", Michel Brekelmans, 17 May 2018, https://asia.nikkei.com/Opinion/China-must-put-the-private-into-PPP2.
[62] "Roadmap for China: Using green securitisation, tax incentives and credit enhancements to scale green bonds", Climate Bond Initiative, 2016, https://www.climatebonds.net/files/files/CBI-IISD-Paper3-Final-01B_A4.pdf.
[63] 17 June 2020, https://www1.hkexnews.hk/listedco/listconews/sehk/2020/0617/2020061700940.pdf.
[64] "China Green Bond Market, 2019 research report", Climate Bonds Initiative, https://www.climatebonds.net/resources/reports/china-green-bond-market-2019-research-report.
[65] Climate Bonds Initiative, Op. Cit.

Environmental and Ecological Protection, including Climate Change adaptation and resource Conservation and recycling (**Figure 15**).
However, Green Bonds account for less than 1% of China's USD 18 trillion bond market and they still match a tepid domestic demand, because green projects that take a long time to complete are seen as risky, so there is not enough market support.[66]
In order to make Green Bonds more appealing for international investors, on 22 April 2021 China ruled out fossil fuels from eligible financing and China is working on defining a more standard classification of the projects.[67]
In conclusion, while PPP projects are the main vehicle to realize the required environmental protection infrastructures, Green Bonds, including Green Securitisation, are intended to be the main tool to ensure liquidity and support cash flow, nonetheless, green bonds are not enough and PPP mechanism reached a structural limit.
Up to 2016, World Bank monitored around 341 new PPP projects on environmental protection for a total of USD 25.2 billion, 55% in waste management and 45% in water and sewerage (**Figure 16**).
A total of 142 projects are sponsored by China Everbright International, for a total value of USD 9.6 billions, 16 projects are sponsored by Beijing Origin Water for a value of USD 1.3 billion, 14 projects are sponsored by CECEP Guosheng for a value of USD 488.15 million, 11 projects are sponsored by Sound Global for a value of USD 331.77 million; out of the 5 projects sponsored by foreign companies, two are sponsored by Engie (Suez) for a value of USD 1.2 billion.
The remaining 153 projects, worth a total of USD 12.2 billion, represent 48.1% of the invested capital and each project has a different sponsor. The concentration index in the top four companies (CR^4) is 46.4%: an industry in the range 40% - 70% is to be considered on the level of oligopoly. Even with an overabundance of financial means, a limited number of State-Owned and Listed companies cannot take on by themselves to the huge wave of required investments: designing, building and operating complex facilities, such as water treatment, waste treatment and recycling, requires availability of well trained staff, with senior experience in problem solving, since environmental protection is not an exact science and it requires a deep knowledge that comes in learning by doing.
So many PPP projects all at once require overstretching of senior staff, while new generations of middle and high ranking managers and professionals requires ten to fifteen years, including university education, to rise to the occasion: Environmental Protection Market in China is suffering skill shortage and it is in need to rise the "capacity building" of both the public utility companies and the local Governments.
Both, in fact, reacted to the lack of capacity and skill by resorting to a "one size fits all" approach, in an attempt to introduce a forced standardization of processes, but the results could only be approximate or even lead to waste of money and sunk investments, to the point that, on several occasions, the Ministry of Ecology and Environment reacted by sending inspectors to try to combat the phenomenon.[68]
Such lack of skill and capacity building could be achieved in a mix of two ways:

- in the short term and middle term, by attracting a number of foreign environmental protection companies that have available capacity and experience in the industry;

[66] "China leads global green-bond sales boom but faces headwinds", 1 April 2021, Reuters, https://www.reuters.com/article/us-china-bond-green-idUSKBN2BO4FP.
[67] "Clarity on green bond issuers underlined", 23 April 2021, China Daily, http://global.chinadaily.com.cn/a/202104/23/WS60821f0aa31024ad0bab9c58.html.
[68] "Ministry: No tolerance for rigid approaches to local pollution", China Daily, 20 September 2019, https://www.chinadaily.com.cn/a/201909/20/WS5d84971ca310cf3e3556ca79.html.

- in a middle-long term, by training the staff and by letting the staff enough time to accumulate experience about problem solving. This approach may lead in making mistakes that other operators have already faced and solved, that's why partnerships with foreign experienced environmental protection companies may be even more beneficial.

However, foreign industrial investors in PPP projects are much less welcome than financial investors in green bonds: in the aforementioned case of the 341 PPP projects monitored by World Bank, only 4.8% were those involving foreign sponsor, as well as the aforementioned article of Nikkei Asia stated that foreign only 2% of PPP participating companies were coming from abroad, out of the 572 projects monitored by the Ministry of Finance's China Public Private Partnerships Center.
The attitude towards foreign environmental protection companies is well explained in some administrative documents at province level, such as the *Chongqing Environmental Protection Industry Cluster Development Plan* (2015-2020)[69] and the *Sichuan Province Energy Conservation and Environmental Protection Equipment Industry Development Plan* (2015-2020).[70]
Those documents reveal a very clear market layout, environmental protection companies are divided into 3 tiers:

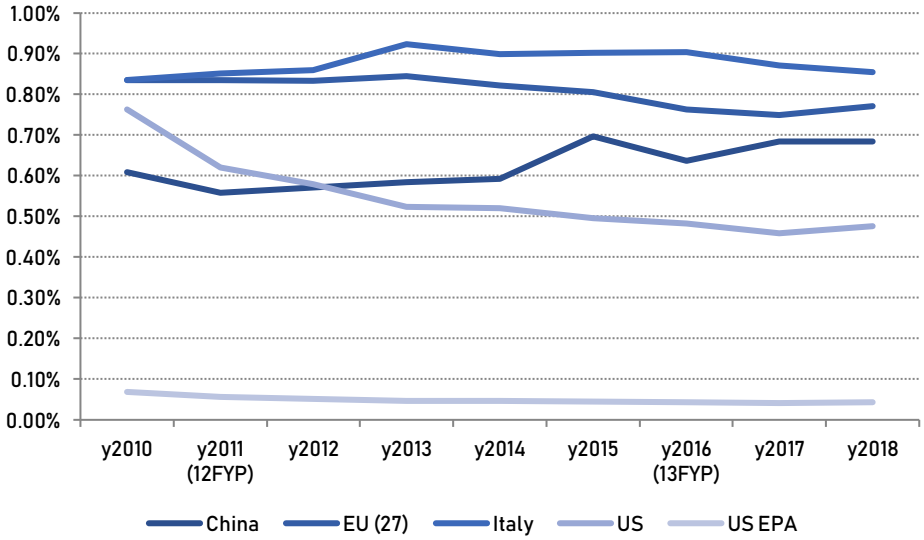
- The first tier is made of public utility companies and those State-Owned and Listed companies that act as EPC contractors in PPP projects. It is not unusual that a company owned by a provincial Government acts as a public utility company in its Province and as EPC contractor in other Provinces, they also invest in technology manufacturing, R&D in order to collect a portfolio of patents.
- The second tier is made of smaller companies, specialized in specific processes and technology, usually invested by the first tier companies; they are also called "backbone companies" and their purpose is to be the first level providers of the first tier companies.
- The third tier is made of all the other companies, including all the foreign ones. According to CAPEI (China Association of Environmental Protection Industry) the environmental protection companies in this tier are around 20,000. 90% of those companies are in the fields of prevention and control of water and air pollution and treatment and utilization of solid waste resources, only about 4% are considered large-scale companies with revenues of more than RMB 400 million (~ USD 62 million).[71]

Domestic second and third tier companies are encouraged to establish partnerships with foreign ones in order to acquire "core and advanced technologies": the designated place of the foreign companies in the Chinese market is as technology providers of second and third tier domestic companies.
With the massive use of PPP projects and the increasing number of companies in second and third tiers, the Chinese Government also fostered the constitution of Trade Associations and Federations at national and local level, whose members are Companies and top management is composed of former public managers, reaching a complex map of market stakeholders (**Figure 17**).

[69] "重庆市环保产业集群发展规划（2015—2020年）", "Chongqing Environmental Protection Industry Cluster Development Plan (2015-2020)", http://www.cq.gov.cn/zwgk/zfxxgkml/szfwj/qtgw/201504/t20150406_8613837.html.
[70] "四川省节能环保装备产业发展规划（2015—2020年）". "Sichuan Province Energy Conservation and Environmental Protection Equipment Industry Development Plan (2015-2020)", https://huanbao.bjx.com.cn/news/20160630/746995-5.shtml.
[71] "Leveraging Private Sector Participation to Boost Environmental Protection in the People's Republic of China", Asian Development Bank, April 2020, https://www.adb.org/publications/private-sector-environmental-protection-prc.

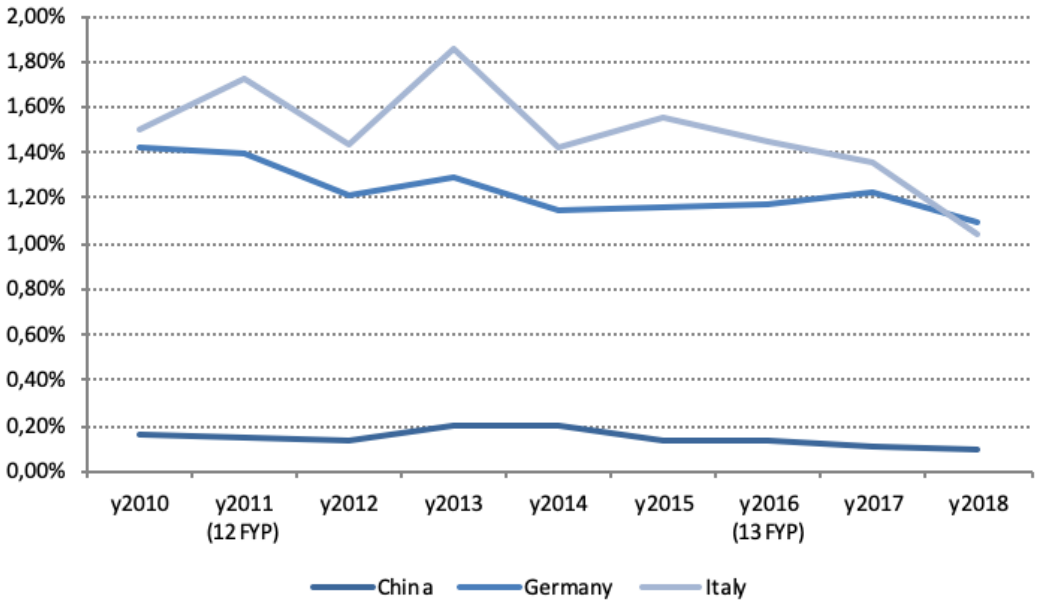
Nonetheless, regarding foreign companies, the "*National Sword*" operation (the 2017 ban on importation of recyclable scrap materials), just by the name, is a crystal clear political statement: environmental protection and circular economy are a domestic business.

Figure 10: Government Expenditure on Environmental Protection on % of GDP between 2010 and 2018.



Sources: Author's own elaboration on data from China Statistical Yearbook, Eurostat, US EPA.[72]

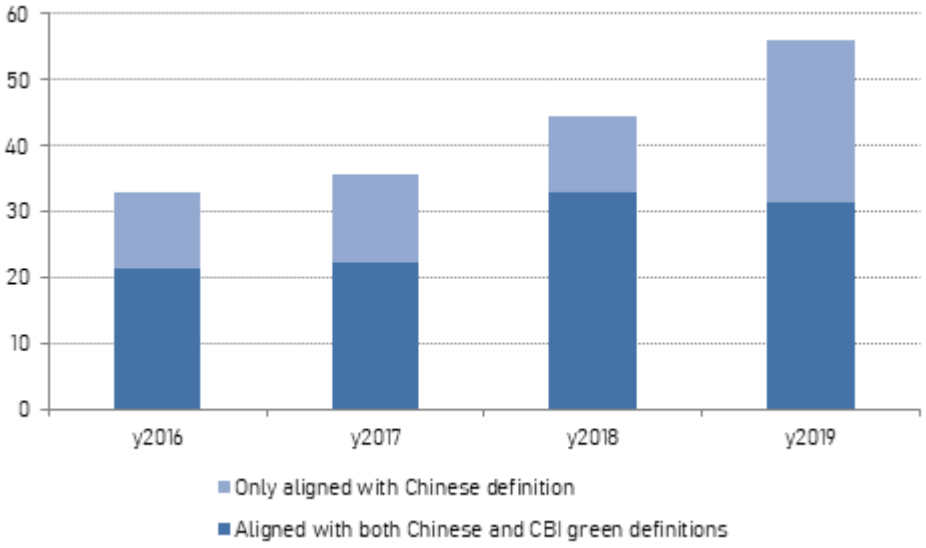
Figure 11: Investments completed in treatment of industrial pollution on percentage of total industrial investments.



Sources: Author's own elaboration on data from China Statistical Yearbook, Eurostat.

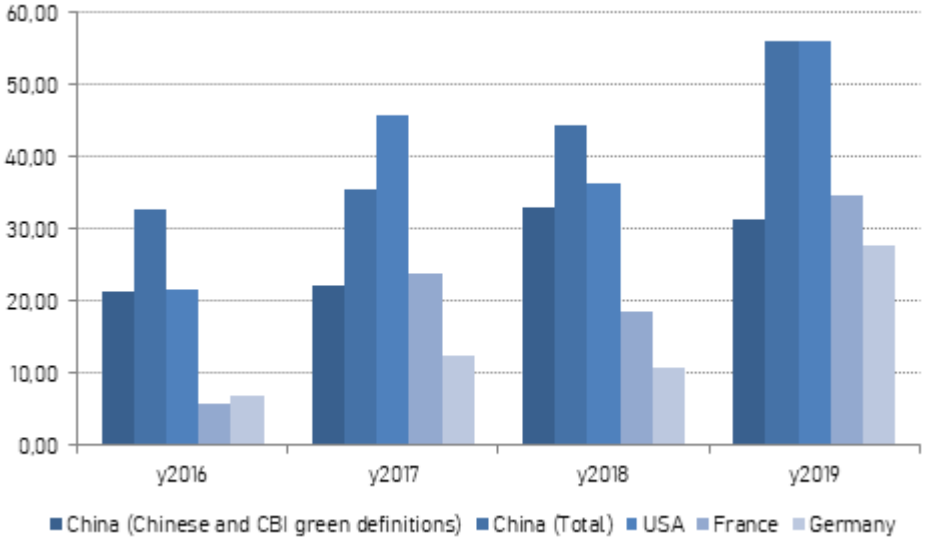
[72] US EPA is the federal budget (enacted for EPA), US values estimated assuming that the federal budget covers, on average, 9% of the total budget for environmental protection, including all the 50 States (real data could be lower, due to cuts of many States during Trump's Administration).

Figure 12: Green Bonds issued by China between 2016 and 2019, value in Billion USD.



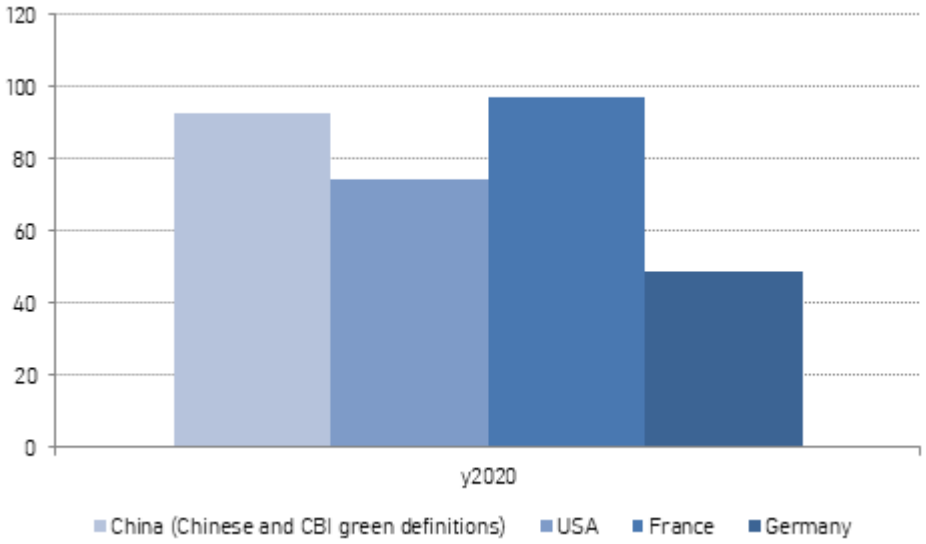
Source: Author's own elaboration on data from Climate Bonds Initiative.

Figure 13: Green Bonds issued between 2016 and 2019 by the 4 leading Countries, value in Billion USD.



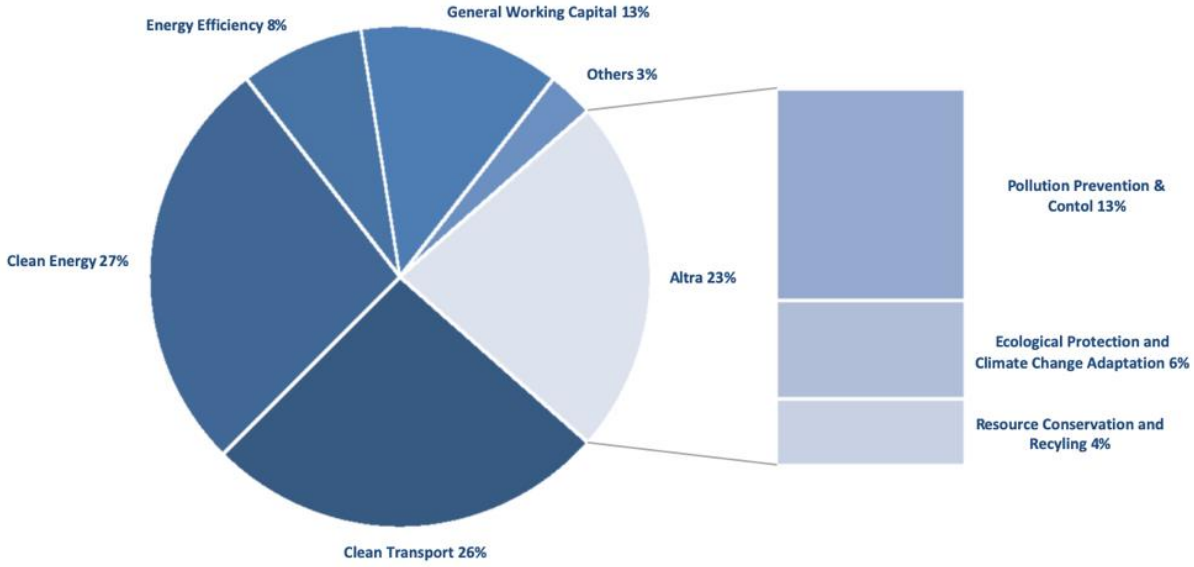
Source: Author's own elaboration on data from Climate Bonds Initiative.

Figure 14: Green Bonds issued in 2020 by the 4 leading Countries, value in Billion USD.



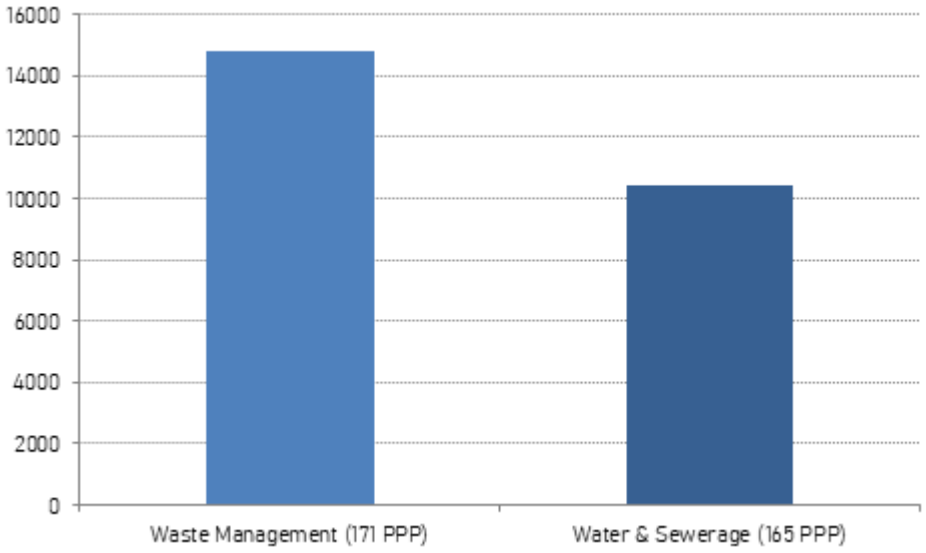
Source: Author's elaboration on data from Climate Bonds Initiative, value in Billion USD.

Figure 15: Use of proceeds by China's domestic definition, year 2019.



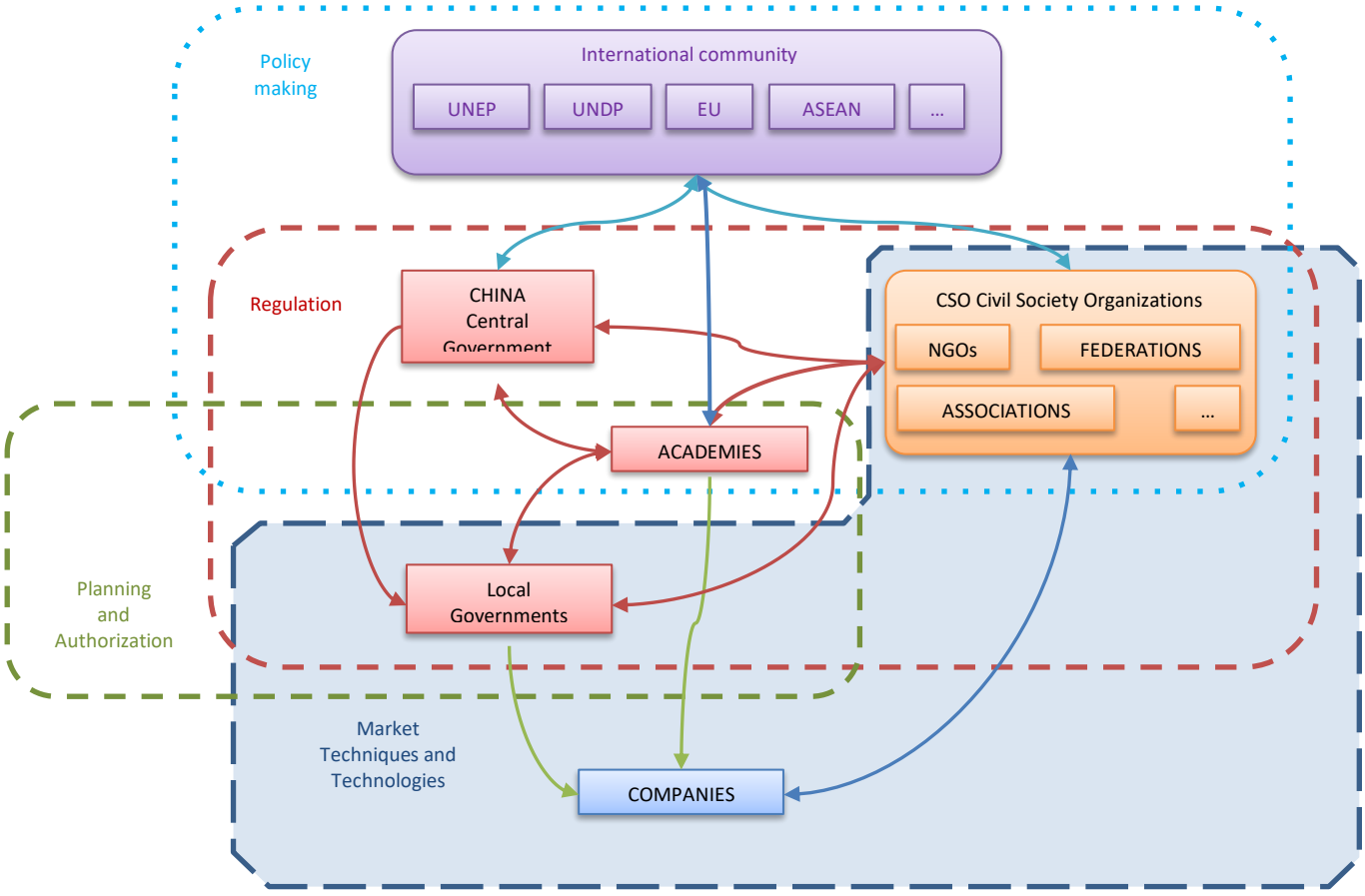
Source: Author's elaboration on data from Climate Bonds Initiative.

Figure 16: New investments in PPP projects in China between 2015 and 2019 for Waste Management and Water & Sewerage, value in Million USD.



Source: Author's elaboration on data from the World Bank PPI database.

Figure 17: Stakeholder's map in Chinese Environmental Protection Market.



Source: Author's own elaboration.

3.2 The impact of 14th Five Year Plan and long-term strategies

3.2.1 Decarbonisation

The 14th FYP made a world media sensation for its pledge to peak CO_2 emissions by 2030 and achieve carbon neutrality by 2060; some commentators celebrate the Plan as the China's blueprint decarbonisation and the jumpstarting of China's industrial decarbonisation revolution, others are very sceptical and think about the pledges just for the sake of form.

After China surged as the Largest Economy in backing up Paris Agreement, after US withdrawal, a declaration about the timings for the peak emissions and the carbon neutrality was the least political commitment to undertake, which China delivered in the first available framework programme.

Anyway, 121 Countries out of the 190 enforcing the Paris Agreement,[73] together with the European Union, already pledged to achieve carbon neutrality by 2050: China's choice delays its carbon neutrality by 10 years.

In 2018, China accounted for 28,56% of the World CO_2 emissions, around double of those of the US and three times more than European Union (**Figure 18**); such a huge amount in itself has measurable consequences on China. For instance, climate change is quickly melting the glaciers of the Hindu-Kush-Himalayas region, the so-called "Third Pole", that is the water source of all the major rivers between India and China, including the Yangtze River.[74] China has been struggling with climate adaptation along the Yangtze River for a few years now, with the violent floods and unpredictable droughts, that, in combination with severe pollution and water exploitation, raised so much concern to the point that president Xi Jinping took action on his own motion: on January 2016, after an inspection visit in Chongqing, he ruled out major development projects along the Yangtze River at a top-level meeting to finalize guidelines for the economic belt along the river, he urged officials from Provinces along the river to concentrate on ecological restoration and protection and to avoid large-scale development. The same year, the central government issued a plan for the Yangtze River Economic Belt to coordinate a balanced and sustainable development in the region, which covers 11 provinces and municipalities, including Hubei, Hunan, Shanghai and Chongqing, and is home to about 40 percent of the country's population and GDP.

China is in need to take action against climate change because the fall out of its own emissions are already affecting the country's development. Chinese CO_2 emissions per unit of GDP (**Figure 19**) are one and half times higher than those of the US and three times higher than those of European Union, nonetheless they are showing a continuous improvement at a higher pace than those of the US and EU. On the other hand, Chinese CO_2 emissions per capita (**Figure 20**) are almost at the same level of EU and 2 times lower than those of the US; while US and EU per capita emissions are constantly decreasing, Chinese emissions followed a growing pattern that is becoming less and less steep after 2015. Those two indicators seem to confirm that China's economic development is about to approach its peak emissions.

Although China is the second largest economy in the World, the CO_2 contributions by sectors, compared to those of US, European Union and others, show a pattern much more in line with the ones of developing Countries, with CO_2 emissions for energy production that account for more than 50% of the total, while

[73] Climate Ambition Alliance: Net Zero 2050, UFFCCC, https://climateaction.unfccc.int/views/cooperative-initiative-details.html?id=94.

[74] China Water Risk, "No Water, No Growth", https://www.chinawaterrisk.org/notices/new-cwr-report-no-water-no-growth/.

industry accounts for little less than 28% (**Figure 21**). If China wants to achieve a swift reduction of CO_2 emission, the first area of improvement is energy production by reducing the use of coal, which is the main source of energy of China and causing around 80% of CO_2 emissions by energy source (**Figure 22**). In 2019, China produced about 3.7 billion tonnes of coal and imported 300 million tonnes[75], around 57% of China's thermal coal imports and 40% of its coking coal came from Australia. Amid worsening bilateral ties, China unofficially banned Australian coal in October and again in November 2020. The Energy Research Institute of National Reform and Development Commission, in its 5th annual *China Renewable Energy Outlook* issued in 2020, elaborated two scenarios of CO_2 reduction, one of them based on the *Stated Policies Scenario* (SPS), the other one based on the goal to achieve the *Below 2°C* scenario (B2D) (**Figure 23** and **Figure 24**).
The strategy for the energy transition explored in the Outlook relies on three pillars:

- Energy efficiency is a critical demand-side pillar to ensure the pace and scale of supply-side deployments are adequate to support the required economic growth.
- Electrification and market reforms will change the rules of the game and create the opportunity to replace fossil fuels with electricity in the end-use consumption, in conjunction with decarbonised electricity supply.
- Green energy supply – technological progress and cost reduction allow renewable energy to provide clean energy in bulk, mainly through renewable electricity.

Coal-based power production will be gradually phased out and replaced by electricity from renewable energy, mainly solar PV and wind turbines. The share of renewables in power production shall increase to 88% in 2050 in the B2D scenario and 85% in the SPS.
The Stated Policies scenario has 707 GW of wind and 880 GW of solar to a combined 1587 GW by 2030, and the total installed capacity of wind power and solar PV is thereby higher than the target of 1200 GW. This is mainly due to the economic competitiveness of wind and solar compared with other technologies combined with the target to have a CO_2 peak before 2030.
Among the main indicators listed in Article 3 of Title 1 of the 14th FYP, two binding indicators are listed in the "Green Ecology" section (#14 reduction of energy consumption per unit of GDP by 13.5%, #15 reduction of CO_2 emission per unit of GDP by 18%, but indicator #20, marked as mandatory, that concerns the overall energy production capacity (which must not be less than 4.6 billion tons of coal equivalent), is listed in the "National Security" section.
The 14th FYP does not include any indicator regarding the targets for GDP (differently from previous FYPs), so the indicator #15 does not define absolute values for reduction of CO_2 emissions, while the focus is shifted over energy production, which is addressed in Article 11 of Title 3 "Accelerating the development of a modern industrial system, consolidating and strengthening the foundations of the Real Economy".
The location of the topic reveals that the decarbonisation has its *raison d'être* in the search for a mix that ensures the maximum possible autonomy for China, albeit in the search for a compromise also with environmental and climatic needs: the 14th FYP proposes to increase the share of energy from non-fossil sources to 20% (in 2020 it is 15.8%), so that non-fossil sources can replace shares of imported coal. In fact, the planned investments concern the production of hydroelectric, wind, solar and nuclear energy,

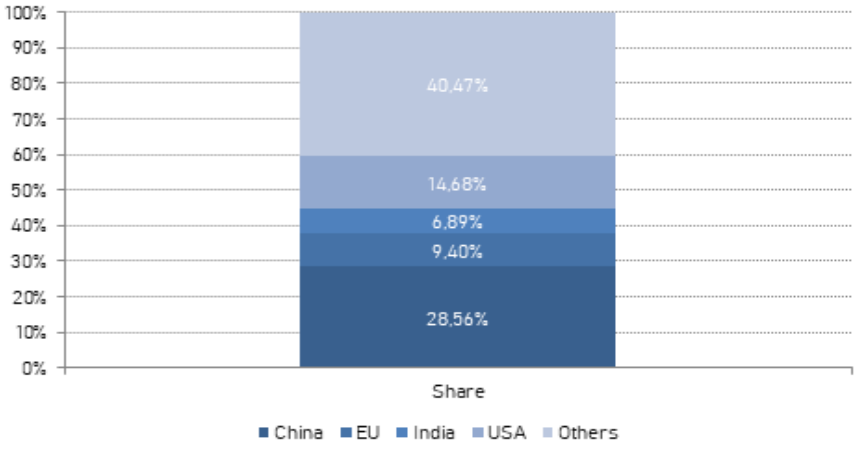
[75] South China Morning Post, "China coal: why is it so important to the economy?", 13 Feb 2021, https://www.scmp.com/economy/china-economy/article/3121426/china-coal-why-it-so-important-economy.

as well as increasing the extension of the ultra-high voltage distribution network, also through the construction of 9 bases for the production of clean energy (**Figure 25**).

In conclusion, because China seems already about to reach its peak of energy and carbon intensity, because the reduction of CO_2 emissions are bound to the replacement of imported coal with non-fossil sources and because those investments are part of the national security policy, most likely China will achieve Carbon Neutrality by 2060, as foreseen by the projections of the Energy Research Institute of the NDRC. As a matter of fact, in the 14th FYP, the decarbonisation is not a strategic goal in itself, but mostly a side effect of national security and energy infrastructure modernization policies, leaving little or nothing to the industrial decarbonisation.

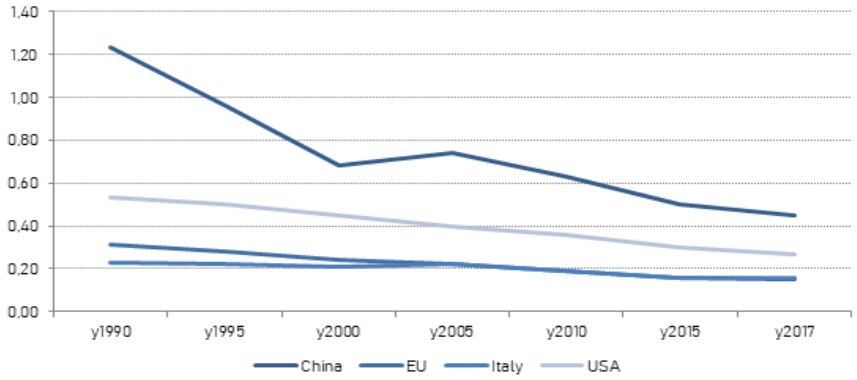
In addition, the projections of Energy Research Institute of the NDRC show that China could achieve carbon neutrality before 2060 and China could already set a more challenging goal, so the strategic choice, compared to the 2050 goal, is to secure ten more years of industrial development with less stringent constraints (or constraints and limitations applied with progressivity).

Figure 18: Contribution to World CO2 emissions, year 2018.



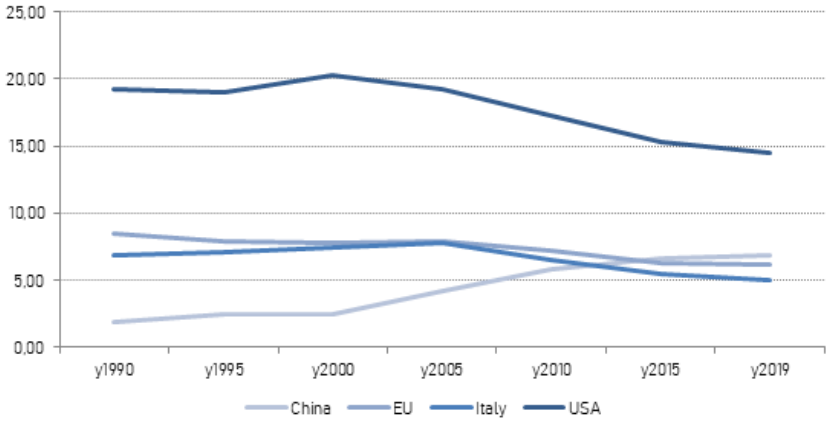
Source: Author's, elaboration on data from International Energy Agency.

Figure 19: CO2 emissions per unit of GDP (SDG 9.4) for China, EU, Italy and US, year 2017, unit kgCO2/USD (2010 PPP).



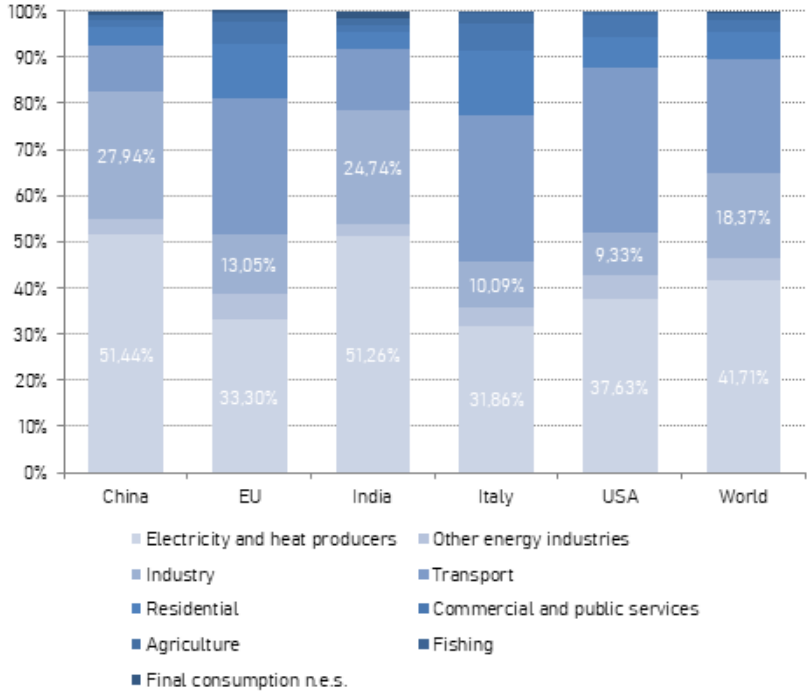
Source: Author's elaboration on data from International Energy Agency.

Figure 20: tCO2 emissions per capita for China, EU, Italy and US, year 2018.



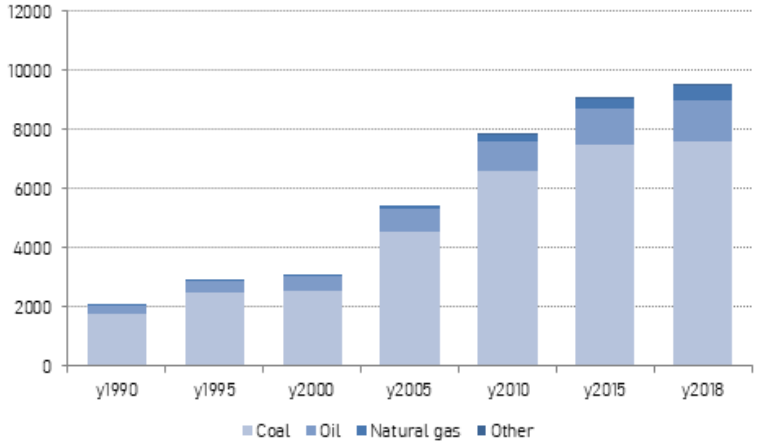
Source: Author's elaboration on data from International Energy Agency.

Figure 21: percentage of CO2 emissions by sectors for China, EU, India, Italy, US and the World, year 2018.



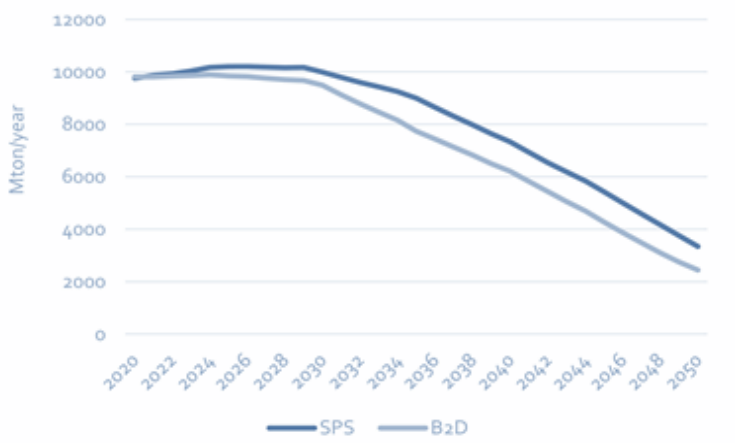
Source: Author's elaboration on data from International Energy Agency.

Figure 22: contribution of CO2 emissions by energy source in China, year 2018, unit Mt CO2.



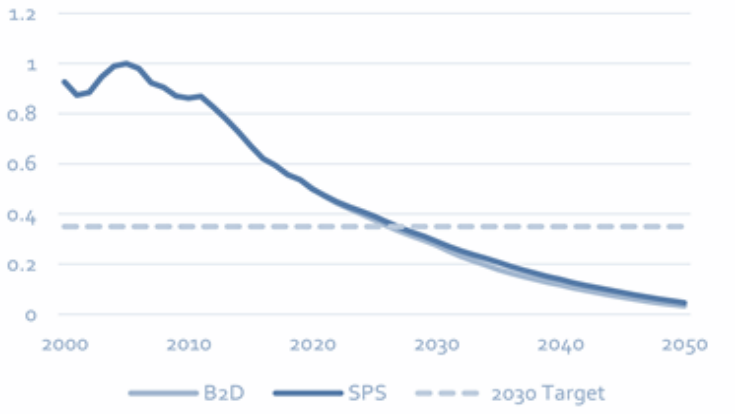
Source: Author's elaboration on data from International Energy Agency.

Figure 23: Energy sector CO2 emissions from 2020-2050.



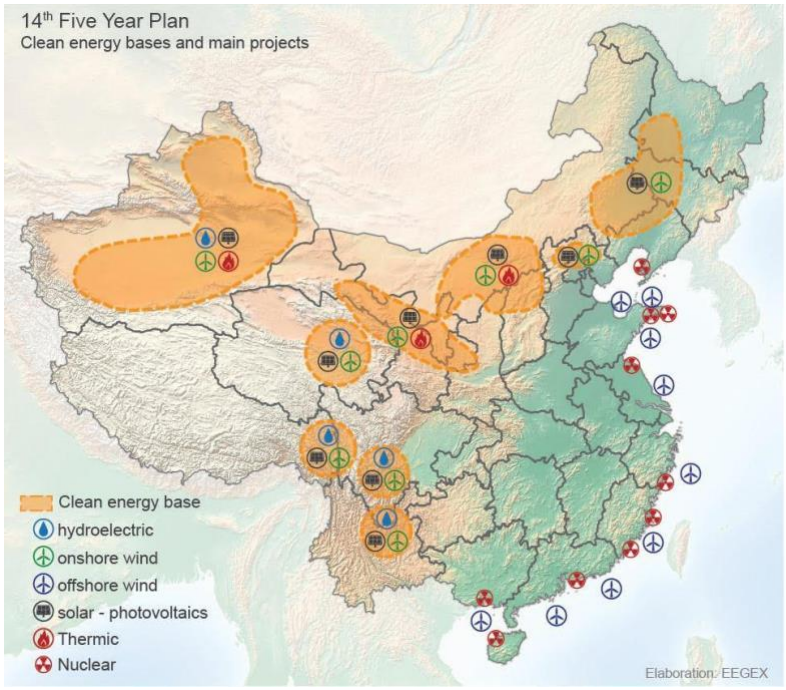
Source: China Renewable Energy Outlook, NDRC, 2020.

Figure 24: CO2 intensity per unit of GDP in the CREO scenarios with 2005 as index=1.



Source: China Renewable Energy Outlook, NDRC, 2020.

Figure 25: the 9 clean energy bases and main projects, according to the 14th FYP.



Source: 14th Five Year Plan.

3.2.2 Ecological and environmental protection

Among the 5 binding indicators listed in in the "Green Ecology" section in Title 1 of Article 3 of the 14th FYP, two binding indicators (#14 and #15) are related to reduction of carbon intensity and energy intensity, the other are related to environmental protection:

- #16 increase the percentage of days with good air quality, in cities at the prefecture level and above, from 87% to 87.5%;
- #17 increasing the percentage of surface water beyond the 3rd class from 83.4% to 85%
- #18 rising the percentage of forest coverage from 23.2% to 24.1%

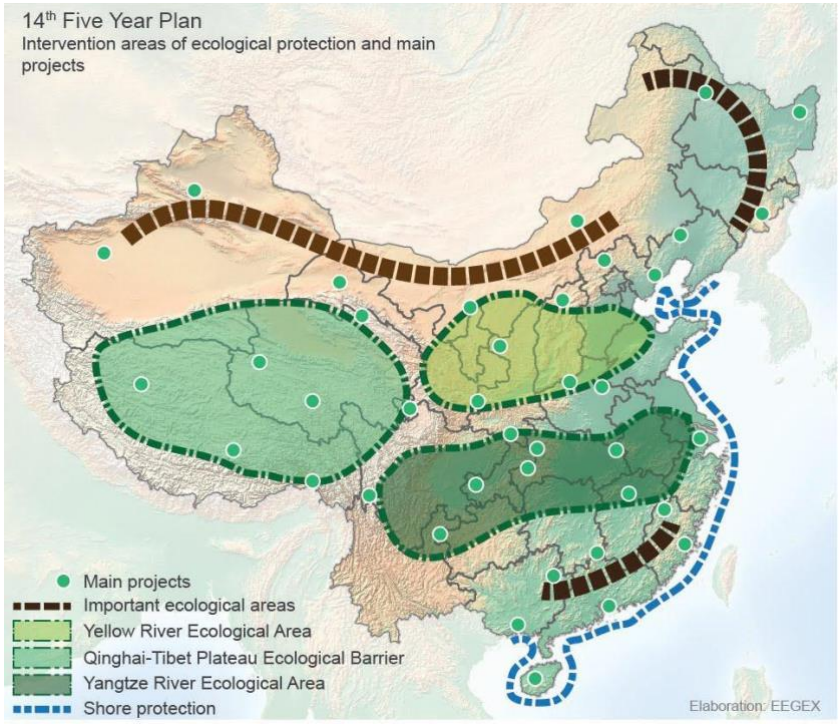
The three articles of Title 11 are dedicated to green development and environmental and ecological protection: "Promoting Green Development and promoting the harmonious coexistence of Mankind and Nature".
Article 37 focuses on "improving the quality and stability of ecosystems", for which this Plan gives a qualitative leap in the approach, evolving the previous management organized by "pilot areas" into a more organic vision, through a general mapping of the macro-areas of intervention, for which it will be necessary to arrive at a systemic management (**Figure 26**).
The Article looks at the three large macro areas that impact on the generation of water reserves in China (the Qinghai-Tibet plateau, the Yellow River basin and the Yangtze River basin); in addition, explicit reference is made to the fight against desertification and reforestation of the northern borders, the protection of the forests of the north-east, the protection of wetlands (55% of which are placed in a protected park regime), the fight against coastal erosion.
The systemic approach, therefore, concerns the determination of all those sensitive areas that must be placed under a protection regime, within which to initiate ecological restoration and preservation policies, accompanied by monitoring and control policies. No less than 270,000 square kilometers (about 90% of the Italian territory) are affected by the priority projects for ecological restoration and preservation and wildlife protection.
The Article also addresses the issue of ecological compensation, also providing for the implementation of financial mechanisms, however the objectives still seem to be linked to an experimentation phase through pilot projects. Article 38 focuses on "continuous improvement of environmental quality" and is certainly the one that had the widest media coverage, because it confirms the Chinese government's objectives to reach the peak of carbon emissions by 2030 and to achieve carbon neutrality by 2060. How to achieve the 2030 goal is left to the drafting of an Action Plan, not yet defined, which will have to manage an energy transition that reduces energy consumption in general, energy intensity and incentivize energy sources to low carbon emissions.
The article, however, goes far beyond the climatic aspects, setting specific objectives for the containment of pollution. As for the air, a 10% reduction of fine particulate $PM_{2.5}$ is foreseen in the cities at prefecture level and above, for the first time the goal of increasing the concentration of ozone is set (but no parameter has been defined) and an overall reduction of 10% of VOC and NO_x emissions is expected. As for water, an 8% reduction of both COD and nitrates, the elimination of water below the 5th category, the complete coverage of sewers in urban areas and the treatment of 90% sludge from non-harmful purification, mainly through centralized incineration plants, the reuse of 25% of waste water in prefectures that have water supply difficulties.

With regard to waste management, the implementation of sorted waste collection at national level is envisaged, the construction of centralized systems at the prefecture level for the treatment of medical waste and industrial waste treatment plants in the vicinity of major industrial parks. Emphasis is placed on the need to improve the control and prevention of environmental risks and to improve environmental governance, through the further refinement of the monitoring and management systems already implemented with the previous five-year plans.

Article 39 gives space to the "acceleration of the Development green transition". The emphasis is on energy saving, without providing indicators, while a reduction in water consumption of 16% per unit of GDP is expected. A general concept of containment of land use is promoted and to maintain building permits for new land under 2 million hectares. The circular economy is promoted in generic terms, hoping for the implementation of tax and tariff policies that take into account the use of resources and emissions.

In conclusion, the 14th FYP addresses in a much more specific way some issues concerning the objectives of ecological protection and management of the main sensitive areas, but it does not specifically address the issue of the improvement of market mechanisms, nor it mentions any reform of public concessions and PPP projects for a wider opening to the private sector. As happened with the 13th FYP, now the responsibility passes to the State Council and the relevant Ministries, which will have to prepare the Action Plans that will address both administrative and regulatory actions, but the setting of the 14th FYP, net of important political declarations, is clearly a transition plan, aimed at consolidating the reforms implemented in the previous two FYPs, but which in some respects seems to take time, postponing to the next FYP more critical decisions linked to the structuring of the market, a slowdown that seems to want to adapt to the overall pace of the country's economic and urban development and it is consistent with the 10 year delay of the goal of carbon neutrality (2060 instead of 2050).

Figure 26: Intervention areas of ecological protection and main projects.



Source: 14th Five Year Plan.

3.3 The commercial relationship between Italy and China

3.3.1 Palatability of Italy for China

The Eco-Civilization process that China is currently experiencing is, in many ways, similar to the process that Italy faced starting from the 1980s. After the Second World War, Italy experienced around twenty years of robust economic and industrial development later denominated the "Italian economic miracle". Thanks to this development, Italy surged among the most industrialized countries, at the cost of environmental, ecological and, in some cases, health safeguard. In the 1980s, the need to identify new models of sustainable development, to overcome the social turmoil of the 1970s, matched a new awareness that a healthy environment is necessary both for human health and as a primary resource for economic development. The Italian Ministry of Environment was established in 1986, the first comprehensive environmental protection law (Legislative Decree 22/1997) was issued in 1997 and a new comprehensive environmental protection law (Legislative Decree 152/2006) was issued in 2006.
After forty years of environmental protection and fight against severe and harmful industrial pollution, Italy achieved an overall good quality of its environment in balance with the economic needs. Italy is currently the second most industrialized economy in European Union after Germany, but its CO_2 emissions per unit of GDP (SDG 9.4) is about three times lower than China's (**Figure 19**), the industrial carbon intensity is about half of China's and below the EU average (**Figure 27**) and the Investments completed in treatment of industrial pollution on percentage of total industrial investments is 10 times higher than China's (**Figure 11**).

Italy is a compendium of techniques, models, know-how and expertise, worthy of forty years of lessons learned, that China can use as catalyser of its Eco Civilization process, in a *win-win* economic partnership that can be beneficial for both the Chinese market and the Italian companies. Nonetheless, in spite of the Chinese Ministry of Ecology and Environment and the Italian Ministry of Ecological Transition did establish the *Sino – Italian Cooperation Program for Environmental Protection* for 20 years, from 2000 to 2020, such an economic partnership never took off.

3.3.2 Italian Market Layout

Until 1990, environmental management was run almost entirely by municipal companies, after that year, thanks to the introduction of Law 142/1990, the market began to be privatized and the municipal companies, while remaining largely owned by the cities, began to follow new management models, delivering diversified services: environment, water and energy; for this reason, they are called "multi-utility" companies.
These are the companies that, having to face and solve the environmental issues of relevant territories, were the engines of the development of techniques and technologies and of the design and construction of infrastructures.
By all means, those companies are the leaders of the environmental protection market, but they are different from the first tier companies in China:

- according to the law (Article 16 of Legislative Decree 175/2016 and previous regulations), those companies, that are bound to work in house for the owning cities, cannot freely operate in the market,
- they operate the facilities but they cannot act as EPC contractors or technology manufacturers.

Consequently, despite being leaders in the supply chain, they are incapacitated to aggregate and accompany the supplier companies abroad (**Figure 28**).
Only multi-utility companies listed in the stock exchange or wholly privately held companies can operate in the market, anyway, out of around 3000 utility companies, only a handful are listed and also the wholly privately held ones focus in operating in the facilities and they don't act as EPC contractors and manufacturers. In this context, technologies, equipment, and techniques for environmental protection are often realized through processes that involve and aggregate a plurality of technological Small and Medium-sized Enterprises and local Universities, according to a mechanism perfectly in line with the Italian economic background.
In Italy, indeed, the manufacturing SMEs are 99.7% of the total, they employ 73% of the total industrial manpower and they produce around 55% of domestic industrial output; Environmental Protection market is not different (**Table 3**).
This size factor requires a flexible management model and especially oriented to customer satisfaction, for which often customized and high quality products are manufactured, as well as a continuous process if innovation; however, it comes with disadvantages, especially because of the short financial leverage, which sometimes leads to exclude the choice of access markets where the Demand requires large-scale production. Limited capability for investments has a deep impact also upon the attitude of Italian SMEs for FDIs. Italian SMEs invest in FDIs mainly to support exports: delocalization of production is very limited, up to 76% of the industrial output is actually mainly manufactured in Italy (despite being poor in raw materials and energy commodities).

3.3.3 Market exchange between Italy and China

Due to the limited financial resources and small size, Italian SMEs display a poor attitude towards FDIs and they are driven by cash-flow sustainability as well as tight risk control. In Italian SMEs' eyes, China is actually a faraway market that requires a huge amount of man hours and expenses with no return just to barely explore a few areas, not to mention the linguistic barrier. Moreover, manufacturing, engineering design and EPC contracting are usually undertaken by three different kind of companies: the environmental protection market in Italy has an almost non-existent rate of vertical integration.
The situation leads to a paradox:

- Italy's supply of knowledge, problem solving, techniques and technologies would perfectly match the Chinese demand, also, the Italian companies do not have neither the size or the interest to invasively enter the Chinese market competing against the over 20,000 local companies, but they are interested in building long-term and loyal partnerships, which could be very beneficial to the Chinese second and third tier companies.
- On the other hand, very few Italian companies arrange visits to China, as well as very few Chinese companies arrange visits to Italy, so the chance of matchmaking is little to none.

In 20 years, the *Sino – Italian Cooperation Program for Environmental Protection* has been recognized as one of the most cooperation of the Foreign Economic Cooperation Office of the Chinese Ministry of Ecology and Environment, having supported more than 200 projects and arranged the

Advanced Training Program, involving more than 10,000 civil servants and managers in 261 courses and 600 study tours. Anyway, the Program has been designed mainly as a technical Government-to-Government cooperation. Between 2015 and 2019, the Program tried to add the market exchange into its mission, by sponsoring the organization of the "Italian Pavilion" at the two main environmental protection exhibitions in China (CIEPEC and IE Expo).
After 2015, the Energy and Environmental Protection Working Group of the China Italy Chamber of Commerce and EEGEX - Energy Environment Global Exchange (a private Italian non-profit organization established with the aim to promote Italian technologies and know-how in China) were active in organizing, each of them on their own, a number of events, workshops, seminars and B2B meetings, and they joined hands with the *Sino – Italian Cooperation Program for Environmental Protection* in order to bring companies at the "Italian Pavilion": the range of the exhibiting Italian companies was between 20 and 40 for each event.

3.3.4 Italian FDI in China

The Environmental Protection and Green Companies already established in China are a few tens and they are mainly mechanical manufacturers of components (such as pumps), machineries (waste grinding, sludge dryers, etc.), HVAC systems and industrial burners. A few companies are specialized in a specific kind of industrial wastewater treatment; one of the few Italian listed multi-utility companies established a joint venture with the purpose to sell its design and technologies for CHP incinerators of Industrial and hospital waste (HERA Group).
Italian Exhibition Group, organizer of ECOMONDO, the major Italian exhibition in Environmental Protection, established in late 2018 a Joint Venture in China, acquiring the majority of the rights on CDEPE – Chengdu Environmental Protection Expo.

3.3.5 Chinese FDI in Italy

Chinese Investors in Italy have been mainly interested in energy and green energy utilities and infrastructures: in 2014, State Grid Europe Limited (SGEL), a company owned by State Grid Corporation of China, spent around 2 billion euros to acquire 35% of holding company CDP Reti with a 30% stake in Snam (energy infrastructure company specialized in natural gas) and 29.9% in Terna (owner of the Italian national transmission grid for high and extra-high voltage power and largest independent electricity transmission system operator in Europe). Between 2015 and 2018, Ladurner Ambiente SpA, a prominent Italian environmental engineering company, has been acquired by Zoomlion Heavy Industry Science&Technology Co., Ltd.

3.3.6 How to build a better match-making between Italy and China (in Covid-19 age)

While the listed utilities, such as HERA Group and SNAM, are already active in China, establishing a lively market relationship between Italy and China means involving Small and Medium-sized Enterprises.
Megaprojects and large investments are bound to be out of reach of SMEs: although those projects can have a strategic meaning for some of the few listed utilities, Italian SMEs pragmatically look at a business

that can be consistent with they own means and background. If the number of Italian SMEs visiting China was tiny before the Covid-19 contingency, now that business travels are banned and they will stay so supposedly up to the second half of 2022, matchmaking opportunities are non-existent.
Regarding the market exchange in Environmental Protection with China, Italy is deeply lacking in governance and tools, since the *Sino – Italian Cooperation Program for Environmental Protection* reached its deadline at the end of year 2020 and it has not been renewed.
On May 17, 2021, in a phone call with the Chinese Prime Minister Li Keqiang, the Italian Prime Minister Draghi pointed out the need to strengthen the cooperation in the fight against climate change, also in light of the Italian COP26 co-partnership and the Chinese Presidency of COP15 on biodiversity. Prime Minister Draghi particularly also stressed the need to strengthen and better balance the economic and trade bilateral relations.[76]
At the G7 Summit in Cornwall (June 2021), the Italian Prime Minister Mario Draghi and German Chancellor Angela Merkel and leaders from the European Union sought to emphasize areas of cooperation with China, including Sustainability and Climate Change.[77] If the Italian Government is actually interested in cooperating with China on Sustainability and Climate Change, strengthening and balancing the economic and trade bilateral relations, a new bilateral cooperation framework is in need, but with different mechanisms and assumptions from the previous one.
Government to Government technical assistance should be one of the missions of the new platform, whose main goal should be bridging the private and the public sectors between Italy and China, keeping in mind that the main Italian business beneficiaries shall be SMEs. The new cooperation should be an inclusive Public-Private Partnership, open to Institutional and private stakeholders in Italy and in China, including the China Italy Chamber of Commerce, exhibitions and congresses, civil society organizations, trade associations and federations, acting as a matchmaking Platform. Matchmaking is crucial, because there is no value for Italian SMEs to compete namelessly in the Chinese third tier as well as there is no value for first and second tier Chinese companies to spend time randomly scouting Italian companies that are not fitting their needs. A matchmaking mechanism referenced at an institutional level is a key element, with a workflow defined in stages, with the preliminary ones giving priority to digital tools in order to avoid useless expenses for travels, keeping in mind that, for a while, business travel won't be possible, but business never stops.
Boosting commercial relationship with Italian SMEs requires a number of enabling characteristics:

a) ***Fair and trustful relationship between the industrial partners***
   In the Italian manufacturing industry, the company's key decision maker is mainly the entrepreneur in the position of managing partner. The individual responsibility of the entrepreneur is particularly felt towards the entire organization and towards the family which, in most cases, owns the company. While the company's managers aid in fully understanding the pros and cons of a strategic deal, the entrepreneur's main focus is about the risk management of the uncertainties: finding trust in the commercial partner is the key. That's why, when the deal is critical or game changing, Italian companies seek, above all, mutual understanding and direct and personal relations with the partners.

[76] Italian Government, Presidency of the Council of Ministers, May 17, 2021, https://www.governo.it/it/node/17171.
[77] "Divisions on China emerge among world leaders in tense G7 meeting", CNN, June 21, 2021, https://edition.cnn.com/world/live-news/biden-g7-summit-updates-06-12-2021-intl/h_bc731d8d7fc5262d194a5aa2edabc278.

b) *Predictable market access, in order to quickly generate cash flow*

Italian SMEs usually lack financial resources, thus cash-flow management is a priority. Undertaking a long term industrial plan with inadequate incomings, at least to cover the direct expenses in the short and middle time, is usually a deterrent for the key decision maker, unless market accomplishment is very well predictable, allowing the company to search for third-party financial resources to invest into the new plan.

c) *Third-Party financial support*

One of the key objectives of SMEs is to avoid financing with their own means (Italian SMEs are among the least indebted in EU) so as not to jeopardize the assets of the company and, mostly, of the owner family. When dealing with international trade and investments, the Italian Companies can resort to the aid of CDP (Cassa Depositi e Prestiti), the Italian State-Owned investment bank, for special loans and for export credit and insurance, nonetheless, the intervention of CDP is not a given and it is limited by many constraints, so a key factor is the availability of Third-Party financial support in the destination Country, such as Venture and Investment Funds and subsidies.

d) *Strong industrial and IP protection*

Mostly when related to partnerships that include Technology Transfer, protection of the company's assets is mandatory for the Italian entrepreneurs. Italian companies usually prefer to protect their key technologies and products through industrial secret than through patents, an unfavourable situation in international deals with China, due to very different law frameworks in industrial and IP protection. The risk that the Italian companies might lose the Intellectual Property, or that its knowledge is stolen and used against it for unfair competition, is perceived as very high by the Italian entrepreneurs; that's why the technology transfer process shall be assisted by legal experts in both Italian and Chinese law systems and the negotiation requires a thorough investigation of all the risks.

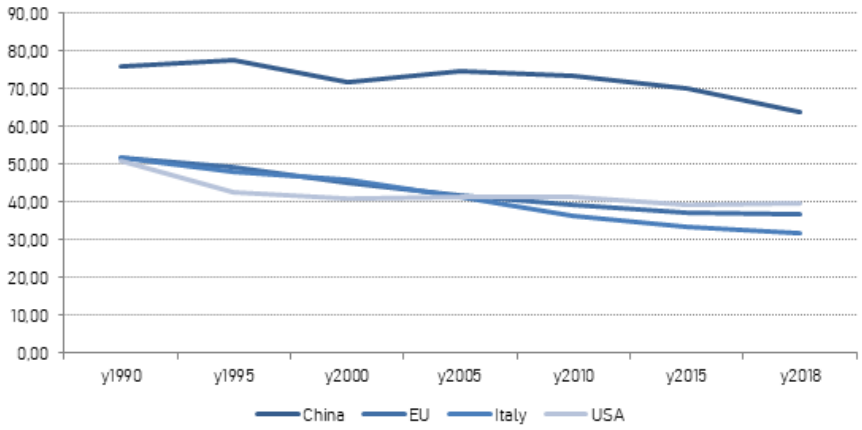
e) *Innovation*

Industrial Innovation is the key to face the modern challenges in the environmental protection and sustainability industry, among which: digital transformation, new technologies, new business models, major industrial transitions in energy and transport systems, etc. Innovation must be included in the industrial cycle of SMEs, in order to change, step by step, processes, products and strategies, in order to win the challenge of competitiveness and productivity with continuous, small and cost effective investments, with direct and measurable returns. Joint innovation among Italian and Chinese partners is a win-win key to rise profitability and competitiveness.

In the past years, the Executive Agency for Small and Medium-sized Enterprises (EASME) of the European Commission, through the program for the *Competitiveness of Small and Medium-Sized Enterprises* (COSME - cluster go international) granted the *European Cleantech Internationalization Initiative* (EC2i), a pilot project integrating the goals and strategies of five leading European cleantech clusters with the aim to internationalise European cleantech SMEs in China and the United States and

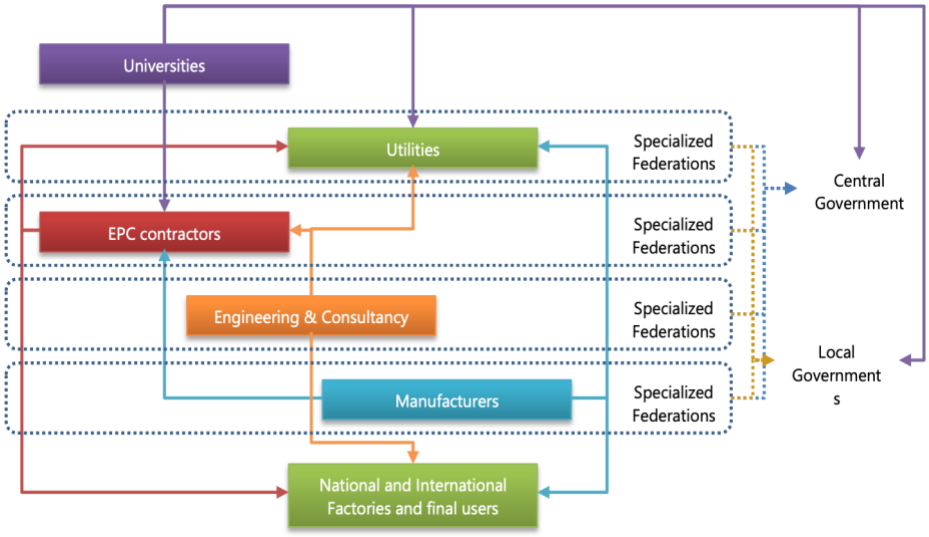
helping them in the target markets, by identifying local market opportunities and by developing strategic partnerships with local stakeholders.[78]
This kind of experiences set the baseline for the cooperation platform involving Italian SMEs in the environmental protection industry.

Figure 27: Carbon intensity of industry consumption (gCO2/MJ).



Source: Author's elaboration on data from International Energy Agency.

Figure 28: Players' layout in Italian Environmental Protection Market.



Source: Author's elaboration.

[78] See for details: https://www.internationalcleantechnetwork.com/post/success-story-european-cleantech-internationalisation-initiative-ec2i.

Table 3: Kind of players in environmental protection and green market in Italy.

Sector	Prevailing Ownership	Prevailing Size	Prevailing Markets
Energy utilities	*Listed*	*Large*	*National and EMEA, Latin America*
Waste, Water and sewerage utilities	*State-Owned (local level)*	*Large*	*National (local-level)*
Industrial waste and hazardous waste utilities	*Privately held*	*SME*	*National (local-level)*
EPC contractors	*Privately held*	*Large and SME*	*National and EMEA*
Engineering and consultancy	*Privately held*	*SME*	*National and EMEA*
Manufactures	*Privately held*	*SME*	*National and International*

Source: Author's elaboration.

Some remarks on Italy-China cooperation on STI

The Jesuit epic in China and Father Matteo Ricci's scientific work represented a milestone in the history of the meeting of civilizations and world science. His contribution was of paramount importance, since he unequivocally marked out the route that favored the encounter between Confucian tradition and Christian culture, often running counter the criticisms brought forward by the Holy Church of Rome. Scientific commitment represented for the Jesuit Father almost a mission within the mission, although he never lost sight of the primary objective of his presence in China: the evangelization. Along with various works of religious nature, Matteo Ricci was also the author of important scientific works (about 50% of his production in Chinese), as it is well known. It is worth stressing how, by translating scientific works in Chinese, the dogmatic Father Matteo Ricci was able to build a real bridge between the Western and Eastern scientific knowledge developed up to that time.

Moreover, it should be emphasized that Father Matteo Ricci, apart from the first two editions of the World Map, could not have created his works without the decisive support of his invaluable collaborators Xu Guangqi and Li Zhizao whom worth the same merits that can be attributed to the Jesuit Father. As such, there is every indication that cooperation between the West and the East started precisely thanks to Father Matteo Ricci's mission to China. A cooperation that still lives and permeates today in the open dialogue between the two cultures.

In modern times, cooperation on Science, Technology and Innovation (STI) between Italy and China started at a very early stage of China's opening up to the world, precisely in 1978 with an intergovernmental Cooperation Agreement on Science and Technology (S&T) signed by the two countries. Throughout the years, changing dynamics in the international scenario have impacted on the evolution of such cooperation. However, the successful examples, both in space and in particle physics, show the advantages of implementing a strategy when engaging in scientific collaboration with China.

It is advisable to establish a collaboration that involves a large community of researchers and has a common history, given for example by the fact that Italy has trained many Chinese researchers in the field of particle physics. This also prevents one from considering China as a distant country where undoubtedly the difficulties of communication and cultural barriers, not least the linguistic one, are remarkable. Such an approach would ultimately narrow the gap and make China a country easier to engage with. A mechanism for managing the specific area of collaboration should also be established. Such a mechanism would be equally enforced by the representatives from each party, with the aim of safeguarding and promoting national interests on both sides. Bilateral research should also enjoy consistent and continuous funding. Cooperation may result in a series of inefficient efforts if a long-term perspective is not taken into account, especially with a large country such as China where an approach of this kind has always been implemented thus far.

On the contrary, isolating China – one of the most technologically advanced countries with great human and financial resources – is definitely a short-sighted strategy. For example, a long-term vision for collaboration in scientific fields such as space may be a fundamental element bringing the two countries on an equal level and allowing one to get direct knowledge of Chinese technologies and their state of advancement. As the case of the CSES satellite has shown, Italy alone could not have faced the costs for the launch of the satellite without China's significant contributions. It was therefore a great success of the bilateral cooperation in space and the realization of a scientific enterprise that benefits both countries and an example of *win-win* partnership with China.

Another very important aspect, which is insufficiently considered but extremely important, is the fact that thanks to collaborations of this kind, China acquires the awareness of being part of a wider scientific

community which it must collaborate and, above all, exchange data with. Encouraging China to align with the open data policy is in fact essential for scientific cooperation at the international level and may foster further progress in this realm.

Italy has proven that it can play a fundamental role in favoring communication between the various international actors when it comes to STI cooperation, especially thanks to its ability to dialogue and collaborate with China. Italy undoubtedly has a clear position within Western alliances, yet it has national interests that must be defended. However, as a result of the changing international political environment in recent years, Sino-Italian STI bilateral relations have weakened, despite Italy's success and advantageous position in space cooperation with China. While the signing of the MoU on the BRI initially suggested more room for cooperation, Italy refrained from extending the Sino-Italian space collaboration, this way leaving room to other European actors, such as France.

As far as Environmental Protection is concerned, after 20 years of full steam development, China entered the new millennium with such an amount of pollution to raise an ever growing social alarm and concern, due to its impact on human health. The set of structural reforms laid down with the 12th FYP were intended to tackle environmental pollution and enforce ecological protection with a pincer movement, by rising a way more stringent regulation and setting market mechanisms, in order to transform environmental protection into a business opportunity, actively involve both population and companies and attract industrial as well as financial private investors. The 2015 Reform of the Public-Private-Partnership (PPP) opened the possibility for the private sector to invest in environmental facilities like wastewater treatment plants, combined heat and power incinerators, waste treatment, etc. As reported in Section 3, from the financial point of view, China's main solution to finance cash flow of PPP projects is Green Securitisation. However, green bonds account for less than 1% of China's USD 18 trillion bond market and they still match a tepid domestic demand, because green projects are perceived as risky as they take a long time to complete, so there is not enough market support. Thus, while PPP projects are the main vehicle to realize the required environmental protection infrastructures, Green Bonds, including Green Securitisation, are intended to be the main tool to ensure liquidity and support cash flow. Nonetheless, green bonds are not enough, and the PPP mechanism reached a structural limit. Another issue relates to the fact that the Environmental Protection Market in China is suffering a shortage in skills and needs to raise the "capacity building" of both the public utility companies and the local Governments. Such lack of skill and capacity building could be achieved by employing two different yet complementary strategies. In the short and middle term, by attracting a number of foreign environmental protection companies that have available capacity and experience in the industry. In a middle-long term, by training the staff and by giving the staff enough time to accumulate experience about problem solving. This approach may bring about mistakes that other operators have already faced and solved, that's why partnerships with experienced foreign environmental protection companies may be even more beneficial.

Nonetheless, regarding foreign companies, the "*National Sword*" operation is a crystal clear political statement: environmental protection and circular economy are a domestic business. The strategy for the energy transition explored in the "*China Renewable Energy Outlook*" issued in 2020 relies on the three pillars mentioned in Section 3: energy efficiency, electrification and market reforms along with green energy supply. Coal-based power production will be gradually phased out and replaced by electricity from renewable energy, mainly solar PV and wind turbines. Since the reduction of CO_2 emissions are bound to the replacement of imported coal with non-fossil sources and because those investments are part of the national security policy, most likely China will achieve Carbon Neutrality by 2060, as foreseen by the projections of the Energy Research Institute of the NDRC. As a matter of fact, in

the 14th FYP, decarbonisation is not a strategic goal in itself, rather a side effect of national security and energy infrastructure modernization policies, apparently leaving nearly no room for industrial decarbonisation. Yet the setting of the 14th FYP, net of important political declarations, is clearly a transition plan, aimed at consolidating the reforms implemented in the previous two Five-Year Plans. In some respects, this strategy seems to take time by postponing more critical decisions linked to the structuring of the market to the next Five-Year Plan. This slowdown suggests China's intention to adapt to the overall pace of the country's economic and urban development and it is consistent with the 10 year delay of the goal of carbon neutrality (2060 instead of 2050).

The Eco-Civilization process that China is currently experiencing is, in many ways, similar to the process that Italy faced starting from the 80s. After the Second World War, Italy experienced around twenty years of robust economic and industrial development – the "Italian economic miracle". Thanks to this development, Italy surged among the most industrialized countries, at the cost of environmental, ecological and, in some cases, health safeguards. After forty years of environmental protection and fight against severe and harmful industrial pollution, Italy achieved an overall good quality of its environment in balance with the economic needs. As a result, Italy is now a compendium of techniques, models, know-how and expertise worth forty years of lessons learned, which China can use as a catalyst for its Eco Civilization process, in a *win-win* economic partnership that can be beneficial for both the Chinese market and Italian companies. In this context, technologies, equipment, and techniques for environmental protection are often realized through processes that involve and aggregate a plurality of technological SMEs and local Universities, according to a mechanism perfectly in line with the Italian economic background.

However, Italian SMEs invest in FDIs mainly to support exports. From their perspective, China is actually a distant market that requires a huge amount of man hours and expenses with no return, just to barely explore a few areas and not to mention the linguistic barrier. As a matter of fact, data from Italian FDI in China's Environmental Protection Market confirm this trend. Environmental Protection and Green Companies already established in China are a few tens and they operate mainly as mechanical manufacturers of components and machineries, HVAC systems and industrial burners, while a small number is specialized in specific kinds of industrial wastewater treatment.

On the other hand, Chinese Investors in Italy have been mainly interested in energy and green energy utilities and infrastructures. While the utilities mentioned in Section 3, such as HERA Group and SNAM, are already active in China, establishing a lively market relationship between Italy and China means involving Small and Medium-sized Enterprises. Megaprojects and large investments are bound to be out of reach for SMEs: although those projects can have a strategic significance for some of the few listed utilities, Italian SMEs pragmatically look at a business that can be consistent with their own means and background. Due to the Covid-19-related travel restrictions, matchmaking opportunities for the Italian SMEs visiting China will shrink even more than prior to the pandemics.

Regarding the market exchange in Environmental Protection with China, since the decommissioning of the *Sino – Italian Cooperation Program for Environmental Protection*, Italy deeply lacks governance and tools. If the Italian Government is actually interested in cooperating with China on Sustainability and Climate Change, strengthening and balancing the economic and trade bilateral relations with a new bilateral cooperation framework is necessary – using different mechanisms and assumptions from the previous ones. Government to Government technical assistance should be one of the missions of the new platform, whose main goal should be bridging the private and the public sectors between Italy and China, keeping in mind that the main Italian business beneficiaries shall be SMEs. The new cooperation should be an inclusive Public-Private Partnership, open to Institutional and private stakeholders in Italy

and in China, including the China Italy Chamber of Commerce, exhibitions and congresses, civil society organizations, trade associations and federations, acting as a matchmaking Platform.
Matchmaking is crucial. A matchmaking mechanism for researchers and entrepreneurs, but also for Italian and Chinese investors, companies, and government administrations referenced at an institutional level is a key element. It should be structured with a workflow defined in stages, with the preliminary ones giving priority to digital tools in order to avoid useless expenses for travels and keeping in mind that, for a while, business travel won't be possible. But business never stops. Specifically, boosting commercial relationships with Italian SMEs requires a number of enabling characteristics: fair and trustful relationship between the industrial partners; predictable market access, in order to quickly generate cash flow; third-party financial support; strong industrial and IP protection; innovation.

In conclusion, this report seeks to investigate the cooperation framework between Italy and China on the STI realm. This aim is accomplished by building both on the successful projects and initiatives illustrated and on the challenges raised and highlighted by such cooperation, as the report puts forward. Cooperation on STI is a priority and a beneficial tool for the development and progress not only of Italy and China but also the global human society as a whole, therefore it should be encouraged at all levels.

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