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**Industrial and green policy in China:
a case study of global competition
in the solar PV industry**

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前言

中国是世界上发展最快的国家之一。自 1979 年邓小平主席提出“改革开放”政策以来，中国在不同领域，尤其是经济和政治领域的地位日益重要。中国也被视为希望走类似发展道路的发展中国家效仿的榜样。然而，即使在进入全球经济后，中国的发展中也存在着障碍及故障。与其他国家类似，中国仍然是一个利用产业政策发展产业的国家，面临着不同的市场障碍和低效率。特别是在 2008 年经济和金融危机之后，中国发现产业政策的使用是不可避免的，正如不同学者所指出的那样。事实上，不同的危机和亚洲等国的成功发展，导致了对产业政策的普遍重新发现，最近年的问题不再是要使用还是不使用产业政策，还是如何最好使用产业政策。产业政策有不同的发展趋势，例如，包括中国在内的亚洲国家倾向于使用有针对性的政策，而不是一般性的政策。总的来说，产业政策可以为克服两种不同的危机使用：在市场失灵和在政府失灵的情况上。市场失灵是指商品和服务在自由市场中没有得到良好的分配。此失灵可能是由于外部性、信息失灵、公共产品和市场控制等原因造成的。政府失灵是指政府试图解决市场失灵问题，但却使情况更加恶化。

有一种新型的产业政策通过不同的市场日益正在受到更大重视：绿色产业政策。绿色产业政策本质上是一种产业政策，其目标也是发展绿色产业，帮助应对气候变化和保护环境的企业。作为一个相对较新的概念，在世界上实施的案例很少，反对使用的意见也很多。然而，实际上，环境应被纳入影响经济的政策中，因为我们将看到，在这一领域做出的选择也会对经济产生巨大影响。

产业政策和绿色产业政策均是在有竞争的情况下制定的。事实上，我们已将缺乏竞争的市场定义为产业政策应克服的市场失灵。

如前所述，中国的快速发展得益于不同的自然和非自然条件。自邓小平主席提出“改革开放”政策以来，中国一直是大量外国投资的来源国，并通过设立不同的经济特区为外国投资者提供优惠政策来促进投资。外国直接投资对中国的发展产生了巨大影响。由于中国的竞争优势：廉价劳动力，这些外国投资者被高度吸引到中国投资。廉价劳动力也意味着廉价商品和服务，因此中国开始在全球市场上占据越来越重要的地位。但是，由于销售的产品质量不佳，中国的声誉很快就毁于一旦。中国开始担心其对出口和外国投资的依赖性，因此政府开始将重点内部的战略性产业。具体来说，战略性新兴产业（SEI）项目是中国不同行业崛起的基

础。如今，现任国家主席习近平正在推动“中国制造 2025”（MIC 2025）项目，旨在提高不同行业的质量和技术水平。

中国政府也越来越意识到气候变化问题。与其他国家相比，这一概念缓缓进入了五年计划和政策的内容。最近年，中国的绝大多数产业政策也涵盖了绿色产业，这表明中国已意识到制造业对国家造成污染的影响。

随着中国进入不同的国外市场，它开始面临一些国家的政治和经济反应，这些国家认为中国可能会损害它们的利益。这种现象在有关改善环境的合作中也很明显。

中国最突出的行业之一是太阳能光伏行业。由于消费需求，中国需要转向可再生能源，因此利用其巨大的太阳能潜力，开始对这一战略性新兴产业进行投资和担保，并很快成为本国最赚钱的产业之一。然而，政策和廉价劳动力导致的低价引起了外国对倾销的担忧。德国尤其受到了中国竞争对手的冲击，因为在此之前，德国是最大的太阳能光伏生产国。中国被指责利用不公平手段在市场上夺权，企图垄断市场，影响全球竞争。欧洲和美国均对这一争端进行了不同的调查。然而，两国面对争端的方式不同，这也显示了两国在政治上的不同态度。在这些争议中提出的主要问题是：优先竞争问题还是优先我们的绿色目标？事实上，中国生产的太阳能光伏产品及其组件是实现欧洲和美国绿色目标的基础。欧洲和美国要在短期内完全转移生产和改变供应链，这是几乎不可能的事情。

在第一章中，我们将讨论有关产业政策、绿色产业政策及其与竞争关系的基本概念和理论。为了解中国的情况，我们要理解本国是如何有效利用这些工具的。我们来看，有很多不同的学者及专家认为产业政策是要使用的，是特别重要的。比如，Rodrik 写到了不同支持产业政策效力的文章。即使不同西方国家支持新古典主义经济学，也就是政府最好不要参与市场活动。竞争被产业政策影响：为了继续发展，企业需要之间竞争，但是不公竞争可能不利。企业获得专营的理由很多，有可能是合法的，有可能是非法的。不同的国家有不同的反垄断法。中国的反垄断法与欧盟的相似，这因为中国进入 WTO 之后，才引进反垄断法。本国不知如何面对竞争的问题，因此欧盟帮助它草拟。

绿色经济的概念越来越重要。几乎所有的国家承认需要在可持续性和环境保护方面做出巨大努力，需要共同目标和不断合作。当讨论绿色竞争时，我们可以证明俩之间紧密相连。

其次，在第二章中，我们将分析中国是如何开始使用产业政策的，以及将绿色理念融入本国政策的系统。我们将分析中国的快速发展如何引起了外国的不同关注，在绿色合作方面也是如此。自 1979 年邓小平主席提出“改革开放”政策以来，中国在是与外国有经济关系。通过经济特区和其他有利政策，中国促进外国投资。前国家主席胡锦涛和温家宝认为中国过于依

赖外国投资，因此他们实行一些为改善中国技术的产业政策。中国政府选择了一些需要收到政府投资的产业，此政策被称“战略性新兴产业”，其中有太阳能产业。目前主席习近平也是产业政策的推手。他继续对战略性新兴产业提供投资，并且引入了中国制造 2025 的至关重要政策。

中国不仅是世界上最重要经济大国之一，也是世界上污染最严重的国家之一。本国承认此问题，并且开始将绿色理念引入不同政策中。现在中国对可再生能源的投资很多，并且也设定碳中和的有望目标。为应对气候变化，中国与其他很多国家合作。即使中欧经济关系很不定，但是两国均注意绿色发展。因此，为以明确的方式共同实现气候目标，中欧两国签署了多项协议。与美国的情况有点不一样。中美的经济关系很复杂，这也是在绿色协议中可见。

最后，我们试图回答上文提出的问题，同时分析中国如何在太阳能光伏领域变得如此重要，以及中国和欧洲和美国之间的争端有何不同。目前太阳能产业很重要。太阳和风是在可再生能源中最可使用的资源。中国太阳辐射资源很丰富，因此本国政府利用此优势以及低成本制造的优势来建立此产业。中国对太阳能产业研发的投资很大，但是光伏出口量与内部消耗量相比差别更大。“金太阳示范工程”是促进光伏产业技术发展和刺激内需的政策。此政策对中国光伏产业特别重要，但是外国的反应有不同。2012 年德国 Solar World 向欧洲委员会提起了反倾销诉讼。中国进入全球光伏产业竞争中之前，德国是太阳能产业最重要的国家。一年之前，德国 Solar World 的美国子公司也提起了反倾销诉讼。两个国家的纠纷很不一样。为更快解决争端，欧盟与中国合作。最后，欧盟承认为达成绿色目标需要中国制造的光伏，因此欧洲委员会设定了从中国进口的光伏成分最低价格。而美国对中国的光伏进口强加反倾销税。最近目前美国总统拜登暂停此反倾销税。

此文论的目的就是分析中国如何发展太阳能光伏产业，如何成为世界上在此产业中最有影响的国家。2022 年中国制造世界上 97% 的晶片和 79% 的多晶硅。这些数据令我们知道中国在此产业有转营。西方要了解如何一方面反垄断，一方面达成绿色目标。

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
AFASE	Alliance for Affordable Solar Energy
AML	Antimonopoly Law
BRI	Belt and Road Initiative
CAI	Comprehensive Agreement on Investment
CASE	Coalition for Affordable Solar Energy
CASM	Coalition for American Solar Manufacturing
CBAM	Carbon Border Adjustment Mechanism
CCCME	China Chamber of Commerce for Import and Export of Machinery and Electronic Products
CCP	Chinese Communist Party
CERC	U.S.-China Clean Energy Research Centre
CPIA	China Photovoltaic Industry Association
CPPCC	Chinese People's political Consultative Conference
DOE	US Department of Energy
ECN	National Competition Authorities
ECP	US-China Energy Cooperation Program
EPIA	European Photovoltaic Industry Association
FDI	Foreign Direct Investment
FIT	Feed-in-tariff
GDP	Gross Domestic Product
HECD	China-EU High Level Dialogue on Environment and Climate

ICN	International Competition Network
ICPAC	International Competition Policy Advisory Committee
IDDS	Innovation-driven Development strategy
IJA	Infrastructure Investment and Jobs Act
IRA	Inflation Reduction Act
IRENA	International Renewable Energy Agency
ITC	US International Trade Commission
MEA	Multilateral Environmental Agreements
MIC 2025	Made in China 2025
MIIT	Ministry of Industry and Information Technology
MLP	Medium and Long Term Program of Science and Technology
MOFCOM	Ministry of Commerce
NDRC	National Development and Reform Commission
NPC	National People's Congress
ODI	Outward direct investment
OECD	Organisation for Economic Cooperation and Development
SAIC	Anti-Monopoly and Anti-Unfair Competition Bureau of the State Administration of Industry and Commerce
SAMR	State Administration for Market Regulation
SEGS	Solar Energy Generating Systems
SEI	Strategic Emerging Industry
SEIA	Solar Energy Industries Association
SEZ	Special Economic Zone
SME	Small-medium Enterprise

SOE	State Owned Enterprise
TFEU	Treaty on the Functioning of the European Union
TRIMS	Agreement on Trade-Related Investment Measures
TRIPS	Agreement on Trade-Related aspects of Intellectual Property Rights
UFLPA	Uyghur Forced Labour Prevention Act
UNCED	United Nations conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNEP	UN Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organisation
WTO	World Trade Organisation

INTRODUCTION

China had one of the fastest development ever experienced in the whole world. Since 1979, year of the opening-up policy introduced by the President at that time Deng Xiaoping, it is becoming increasingly important in different spheres, especially in the economic and political ones. China is also seen as an example to follow from different developing countries that hope for a similar development path. However, obstacles and breakdowns have been part of the Chinese development, even after the entrance on the global economy. Similarly to other countries, China is still a country that uses industrial policies to develop its industries and face different market obstacles and inefficiencies. Especially after the 2008 economic and financial crisis, it discovered that the use of industrial policy is inevitable, as different economists such as Rodrik (2004), Andreoni, and Chang (2016) have shown.¹² In fact, different crisis and successful development of countries like Asian ones, led to a recent general rediscovery of industrial policy, the question now is *how* to best use it. There are different trends of industrial policies, for instance Asian countries, China included, tend to use targeted policies instead of generic ones. Industrial policies are also justified by literature to overcome two different crisis: market and government failures. A market failure is defined in a situation where goods and services are not well-distributed in a free market. This type of failure can mainly happen because of externalities, information failures, public goods and market control. Government failures can happen for instance when the government tries to solve a market failure, but it worsens the situation.

A new type of industrial policy has been gaining importance through different markets: green industrial policy. Green industrial policy is essentially an industrial policy that aims also at the development of a green industry which aims at the fight against climate change and the protection of the environment. As a relatively new concept, few implementations have been made, and a lot of opinions against its use have also been raised, for example when defining what can be considered green and what cannot. Nevertheless, it is a matter of fact that the environment should be included into policies that influence the economy of a country, as we will see that it is immensely influenced also by choices made in this sphere.

¹ RODRIK, Dani, *Industrial Policy for the Twenty-First Century*, Cambridge, Harvard University, 2004. <https://doi.org/10.2139/ssrn.617544>

² ANDREONI, Antonio, CHANG, Ha-Joon, “Industrial policy and the future of manufacturing”, *Economia e Politica Industriale*, vol. 43, 2016, pp. 491–502. <https://doi.org/10.1007/s40812-016-0057-2>

Both industrial policy and green industrial policy exist in a situation where competition is also present. In fact, we have defined uncompetitive markets as a type of market failure that industrial policy should overcome. Competition is essential for the innovation of the industry, but illegal and unfair attempts to gain a monopolistic position should be hindered. The WTO requires that its member states have antitrust laws, we note here that China introduced it only after its entrance on the WTO in 2001, redacting it with the help of both the United States and, especially, the European Union that have been using it since a long time before.

As we have just noted, China had a rapid growth, made possible by different situations, both natural and not. Since its opening-up to foreign markets, China has been home of large investments coming from foreign countries, promoting its flow also by inaugurating different Special Economic Zones (SEZ), where favourable policies were offered to them. FDI had a huge impact on the development of the country. These foreign investors were highly attracted to invest in China also because of its competitive advantage: cheap labour. China took advantage of this internal phenomenon by focusing on export. Cheap labour means also cheap prices of goods and services, so the country started to gain an increasingly important part on the global market in terms of export. Nevertheless, its reputation was soon ruined because of the bad quality of the goods sold. China started to be concerned about its dependence on export and foreign investors, thus the government started to focus on internal investments on industries that were considered strategic. Specifically, the Strategic Emerging Industry (SEI) project was fundamental for the rise of different sectors where China has now the primate. Nowadays, President Xi Jinping is promoting the Made in China 2025 (MIC 2025) project that aims at the improvement of quality and technologies in different sectors.

The Chinese government has also been increasingly aware of the problem of climate change. This concept has entered Five-year plans and policies gradually and slowly if compared to other countries, but this did not undermined the majestic green goals that the country is trying to reach. The vast majority of industrial policies in China also cover green industries, signalling an increasing awareness of the impact that the country has in terms of pollution caused by manufacturing. As China entered foreign markets, it started to face political and economic reactions from countries that feel like they could be damaged by it. This phenomenon is also visible on collaborations regarding the improvement of the environment, that sometimes are undermined by economic interests.

One of the most prominent sector in China has been the solar panel industry. China had a need to shift to renewable energies because of consumption needs, and so it took advantage of its huge solar potential and started to invest and guarantee grants to this strategic emerging sector that soon became one of the most profitable industry in China. However, low prices led by policies and cheap

labours raised dumping concerns among foreign countries. Germany was particularly hit by its Chinese competitors, as it was the largest solar PV producer before it. China was accused to be gaining power on the market with unfair tools, affecting competition with its attempt to monopolise the market. Both in Europe and in the United States there were different investigations over this dispute and they both announced duties to punish those Chinese companies that were reported to be dumping prices. Nevertheless, disputes were faced differently, showing also a different political approach to the country.

The main question that was raised in these disputes was: to give priority to the competition problem or to give priority to our green goals? In fact, solar photovoltaics and its components produced in China are fundamental for the realisation of both the European and American green goals. It is impossible to completely shift the production and change the supply chain in a short period and without any consequences.

In chapter one we will discuss the basic concepts and theories about industrial policy, green industrial policy and their relation with competition. It is important to understand these topics to look at the Chinese situation and understand how it has efficiently used these tools.

Secondly, on chapter two we will analyse how China started to use industrial policies and their attempt to incorporate the green concept on them. We will notice that the fast Chinese development has raised different concerns among foreign countries, also looking at the development of green collaborations between China, Europe and the United States.

Finally, we tempt to answer the question raised above while analysing how China became so relevant in the solar photovoltaic sector and how disputes differ among the European Union and the United States.

1.1 INTRODUCTION TO INDUSTRIAL POLICY

With the rise of different types of crisis on countries all around the world, industrial policies are making a comeback. In fact, we observe that different institutions and scholars are starting to express a bigger approval of these policies previously rejected by the Neoclassical approach that was dominating different institutions.

Going back on time, after the 1990s, the Neoclassical approach was preferred among developed countries. This theory implies a laissez-faire approach to the country's economy, and so, an absent interference of institutions on it, fluctuations are self-correcting. This new rise of industrial policy is particularly relevant to developing countries, which have seen other countries' success through market interventions as an example.

As Aiginger and Rodrik (2020) state on their article “*Rebirth of Industrial Policy and an Agenda for the Twenty-First Century*”, there are several motives for this comeback. The rise of China as one of the most influential country of the world, the slow growth of the manufacturing sector on Western countries, and a huge and fast technological change are phenomenon that sustain the implementation of industrial policies.³

But before going deep down on industrial policy, we should first define it. There have been several discussions and theories about the definition of industrial policy and its application, but after analysing the most influential ones, we are going to follow the Eurofound definition and describe industrial policy as:

“Intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity towards sectors, technologies or tasks. Such interventions are expected to offer better prospects for economic growth or societal welfare.”⁴

(Eurofound)

We have seen the most recent outbreak of industrial policy during the Covid-19 pandemic, where the role of the state became fundamental. In the EU, several state aid rules were loosened in order to facilitate the recovery of some selected industries. These recovery plans did not just aim at the

³ AINGINGER, Karl, RODRIK, Dani, “Rebirth of Industrial Policy and an Agenda for the Twenty-First Century”, *Journal of Industry, Competition and Trade*, 20, 2020, pp. 189–207. <https://doi.org/10.1007/s10842-019-00322-3> . p.189

⁴ Eurofound, “Industrial policy”, Eurofound, 2021, <https://www.eurofound.europa.eu/topic/industrial-policy>, (Accessed March 19, 2023)

economic crisis, but also at the energetic and environmental crisis. Green and digital transactions are driving the rise of industrial policies in European countries.

On December 2022, the President of European Commission Ursula Von der Leyen called for a common industrial policy within the European Union.⁵ This speech was followed by the implementation of a plan that aims at the recovery of state members' green industries following the crises above mentioned, signalling a rising importance given to this type of policies.

On the other part of the world, China has given importance to industrial policy especially since the 2008 financial crisis, intervening on several fronts of the country's economy and development, starting from national champions. China has been taken as an example of the effectiveness of industrial policy, especially from developing countries that want to boost their economy.

Speaking about the 2008 economic and financial crisis, many governments re-evaluated the effectiveness of industrial policy after this violent crisis. It was necessary to boost economic growth after a period of recession, improving the supply-chain and helping firms and industries involved. This huge crisis underlined the imbalances of the market structure and so policies were needed to counterbalance these problems. Warwick (2013) also affirms that many countries, after the 2008 crisis, had the necessity to implement new ways of growth because of frequent demographic pressures⁶, this is also because importance in global value chain is slowly and gradually shifting from manufacturing to services.

We are living in a constantly changing world, which is connected in different ways both economically and socially. Even if different countries focus on different industries based on their resources and advantages, some companies are inevitably in conflict despite the fact that they are located in different countries. In this sense, industrial policies also aim to alleviate harming competition and facilitate the correct functioning of the market without unfair wins.

Another trend we observed in recent years is the rise of the green economy, an attempt to reach economic growth through also an environmental amelioration. How is green economy applied to every country's economic and social situation? We are going to see how industrial policy is fundamental if a government really wants to achieve green goals, also taking into account competition in this sense.

This chapter gives the basic principles of the fundamental concepts needed to analyse China's growth through industrial policies and the shift to green policies. Firstly, some theories over industrial policy are given, we then move to the definition of competition, describing also

⁵ DE VILLE, Ferdi, "The Return of Industrial Policy in the European Union", *Green European Journal*, 2023, <https://www.greeneuropeanjournal.eu/the-return-of-industrial-policy-in-the-european-union/>, (Accessed March 19, 2023)

⁶ WARWICK, Ken, "Beyond Industrial Policy: Emerging Issues and New Trends", *OECD Science, Technology and Industry Policy Papers*, n. 2, Paris, OECD Publishing, 2013. <https://doi.org/10.1787/5k4869clw0xp-en>. p. 11

differences over institutions when it comes to face unfair competition and antitrust cases. The third part of the chapter describes the green concept and how it is implemented in industrial policies, also when it comes to competition on green sectors.

Discussions over industrial policy have been conducted since the very first definition of it, but the difference we have noticed is that in recent years the debate is not about its effectiveness anymore, as Rodrik (2004) underlines, but how it should be designed for the best.⁷ This is especially true after the failure of the Washington Consensus and the recent crisis, for instance the 2008 financial crisis and the COVID-19 crisis. However, this positive approach to industrial policy does not imply a complete consensus all over economists and scholars. We are going to analyse pros and cons of industrial policy risen by different scholars, focusing on the main arguments that lead the discussions, starting from the infant industry protection and concluding with market and government failures.

Therefore, it is best to anticipate that industrial policy can be both positive and negative to the growth of a specific economy. Many studies conducted in different countries have demonstrate that different countries have reacted differently to industrial policies.

We are going to explore examples of both cases and draw a conclusion about its effectiveness.

1.1.1 GENERAL CONCEPTS PRO AND AGAINST INDUSTRIAL POLICY

As Harrison and Rodríguez-Clare (2010) state, the application of industrial policy is justified by three conditions, that are respectively: market failures, internationally competitive sectors/industries, and benefits of the intervention that can exceed losses provoked by an absence of interventions.⁸ In particular, their study was about developing countries and the impact of industrial policies on their growth. The two economists, after a detailed empirical analysis, sustain the idea that developing countries should abandon industrial policies and adopt “softer” policies that imply collaborations between the government and different organisations.⁹ This is especially important given the fact that governments do not have enough information about every single industry on the market and the risk to invest on to the wrong one is huge. Another important fact that goes against industrial policy is corruption. As a government offers financial support to certain industries, several companies will

⁷ RODRIK, *Industrial Policy for the Twenty-First Century*.

⁸ HARRISON, Ann, RODRÍGUEZ-CLARE, Andrés, “Trade, Foreign Investment, and Industrial Policy for Developing Countries”. *Handbook of Development Economics*, Vol. 5, 2010, pp. 4039–4214. <https://doi.org/10.1016/B978-0-444-52944-2.00001-X>.

⁹ HARRISON, RODRÍGUEZ-CLARE, “Trade, Foreign Investment, and Industrial Policy for Developing Countries”. p.4112

try to obtain them also by taking illegal actions and modifying their outcomes proving to be adequate to receive this support. This can lead to a misallocation of resources, it is a waste of time. We are going to discuss these two arguments when talking about market and government failures. Warwick (2013) adds that it is the pressure over a decline in manufacturing industries that made governments to rethink the role of industrial policy.¹⁰ This decline is caused by a sinking demand of manufacturing products, which is linked with the internationalisation of it.

Industrial policy is not new, we can adopt an historical thinking and analyse how today's developed countries have reached their present status. We can easily say that the USA as much as Germany or the UK adopted successful industrial policies in their early stages of development. An interesting fact is emerging from this statement. The US have always been promoters of the free market approach, embracing a consensus against industrial policies. Nevertheless, especially with the rise of China as the next economic superpower, the US adopted several types of industrial policies, for instance the Infrastructure Investment and Jobs Act (IIJA), signed by President Biden in 2021. Policies implemented by the country with the aim to hinder the rise of China are to be discussed on Chapter 2 and 3, where we will take competition on green sectors and, in particular, we will take the solar panel industry as an example.

Asian countries such as Taiwan and South Korea are also good examples of a successful use of industrial policies. For instance, South Korea has developed a plan where 17 sectors where the country is believed to have comparative advantages are recognised, among these we can also find green tech and services. Debates over the East Asia model are still discussed, but what we notice is that their key to success was a great economic support on modern and new industries, rather than a direct emphasis on export, which was actually a consequence of their high investments.

Another supporter of the industrial policy effectiveness is Rodrik (2019), who states in his article that industrial policy debates should be normalised instead of being discussed.¹¹ Outcomes of different policies on different countries are underlined in his article and in particular he sustains the idea of overcoming the problems mentioned above, because they are part of the industrial policy itself.

An important argument when talking about industrial policy is whether it should be selective or not. Putting aside the argument about whether to use industrial policy or not, by giving for granted its use, another important topic is *how* to use it. Should it aim to specific industries or should it be general so it affects different sectors of the country's economy?

¹⁰ WARWICK, "Beyond Industrial Policy: Emerging Issues and New Trends". p.11

¹¹ RODRIK, Dani, "Industrial Policy: Don't Ask Why, Ask How", *Middle East Development Journal*, vol. 1, no. 1, 2009, pp. 1–29. <https://doi.org/10.1142/S1793812009000024>. p.2

At the beginning of this chapter we defined industrial policy as activities that alter specific sectors and tasks. But in the discussion about its definition, some economists believe that these interventions should not be too specific. Thus, we can analyse two different approaches: the first one is the functional or horizontal approach, and the second one is defined as sectoral or vertical approach.

Firstly, supporters of a more functional/horizontal approach believe that policies should aim to R&D, infrastructures and education. By doing this, government measures would benefit different sectors instead of specific industries, and the outcome would be extended to the whole value chain. At first, the European Commission underlined in its definition of industrial policy that it should be horizontal and aiming at the fostering of different sectors connected to each other, but taking also into consideration specific needs of different industries that need a much more sectoral application.¹² Nevertheless, it is gradually shifting to a more targeting view of industrial policy, also taking into account recent trends of the green sectors.

Of course, this type of policies do present some disadvantages. Needless to say, even if some policies are considered “generic”, it is obvious that some industries will receive an higher benefit than others, the impact is still heterogeneous. For instance, when the government decides to invest in an infrastructure, obviously it is aiming to certain industries rather than others. If the new infrastructure project is building an airport and not a railway, we can understand that not everybody would benefit from it.

Another important point against a more generic industrial policy is related to costs. It is easier to monitor costs and benefits when we focus on a certain sector, having in mind where specifically it should be applied and facilitating the analysis of its effectiveness.

Secondly, targeted industrial policies, even if they are more costly, are easier to manage. On the other hand, this approach increases the possibilities of lobbying. However, a general tendency on targeting has been observed, as more and more industrial policies are getting specific to certain sectors, especially, as we said, when talking about green industries.

There is an important shift of focus during different periods of changes on the world. We can observe how the focus shifted to policies oriented to the health systems during the COVID-19 pandemic, and not only to the manufacturing sector itself. Even if described as temporary, policies implemented during the recent crisis are meant to leave their traces for a longer period of time than expected. This type of selective industrial policy is called by Warwick (2013) defensive/reactive policy and it aims at the recovery or the salvation of firms affected by the crisis.¹³ It is exactly

¹² European Commission, “Industrial Policy in an Enlarged Europe”, *EUR-Lex*, COM(2002) 714, 2006, <https://eur-lex.europa.eu/EN/legal-content/summary/industrial-policy-in-an-enlarged-europe.html>

¹³ WARWICK, “Beyond Industrial Policy...”. p.28

during periods of crisis that most economists support the implementation of economic policies. This trend takes also into account our environment.

Targeting is defined by Andreoni and Chang (2016) as fundamental and impossible to avoid¹⁴, even if there is no connection between the degree of targeting and the success of industrial policies. The authors then focus on the idea that targeting inevitably creates conflict, and thus conflict management is needed.¹⁵ Conflict management is divided into “reactive” and “anticipatory”. A reactive conflict management deals with intervention on the so-called losers, and this is why the theory was well criticised. Governments and/or organisations can help firms in trouble both temporarily and with long-term perspectives. Anticipatory conflict management justifies target selection in advance, describing also why certain industries were chosen and the final targets. This method is used in China, where the government announce long-term policies through the Five-Year Plans. Targets and allocation of resources are planned for the subsequent five years, clarifying where the government is going to intervene and where investments are offered.

Finally, Warwick (2013) makes a distinction between strategic and defensive/reactive selective policy.¹⁶ The so-called strategic industrial policy is connected to the two concepts that we are going to discuss on parts 1.1.2 and 1.1.3, namely the infant industry protection and the comparative advantage theory.¹⁷

1.1.2 THE INFANT INDUSTRY PROTECTION

In order to understand better the new applications of industrial policy, it is necessary to comprehend the concept of the infant industry market, described by Pack and Saggi (2006) as the “precursor of modern industrial policy”¹⁸.

Alexander Hamilton first introduced the infant industry theory in 1791, when the United States needed protection from imports coming from Great Britain.

It is a matter of fact that a new industry takes time to be competitive on the market. This given new industry has to learn and ameliorate somehow, and so it uses foreign competitors’ knowledge and skills as references. At the beginning of this stage, costs will be higher but they will get down as

¹⁴ ANDREONI, CHANG, “Industrial policy and the future of manufacturing”. p.494

¹⁵ CHANG, Ha-Joon, ANDREONI, Antonio, “Industrial Policy in the 21st Century”, *Development and Change*, Vol. 51, n. 2, 2020, pp. 324–351. <https://doi.org/10.1111/dech.12570>. p. 339

¹⁶ WARWICK, “Beyond Industrial Policy...”, p.28

¹⁷ WARWICK, “Beyond Industrial Policy...”, p.29

¹⁸ PACK, Howard, SAGGI, Kamal, “Is There a Case for Industrial Policy? A Critical Survey.”, *The World Bank Research Observer*, vol. 21, n. 2, 2006, pp. 267–297. <https://doi.org/10.1093/wbro/lk1001>. p.268

soon as the given industry reaches the foreign one's level and starts to be competitive. The maintenance of the costs level can be assured by government's protection moves, with the risk that if the industry fails to become successful, interest rates over funds would be excessively high. Many countries used this theory as a justification for their protectionists moves, e.g. tariffs over foreign products, quotas on imports etc.. These tools make it impossible to foreign companies to even compete with these infant companies, because their import prices would be highly affected. We observe that an excessive use of this type of protection would lead to disequilibrium on the price market and so foreign countries may be justified to counter-use these tools to protect their local companies.

There have been discussions also over which tool to use in order to protect infant industries. For instance Baldwin (2004), Pack and Saggi (2006) support the idea that direct subsidies are much more effective than tariffs.^{19 20} Direct subsidies are also supported by Harrison and Rodríguez-Clare (2010) in cases where a given company, because of barriers to protect the infant industry, uses low-productive technologies instead of sophisticated technologies so that learning and spill over cases are reduced.²¹ For instance, in the early years of the country's development, the Chinese government used protectionism over services. This means that the government protected local services infant industries, that were mostly national champions, over foreign investors in order to let them grow without directly face external competition.²²

But is protectionism over infant industries really effective? Jansen (2017) stated that tariff and subsidies policies are less effective than R&D policies, and so through an example, she dismantled this type of tool by offering a different solution where firms compete in costs.²³ Moreover, when taking into consideration the sustainable dimension, R&D is surprisingly less effective.

Krugman, Obstfeld and Melitz (2022) presented two main market failures connected to the infant industry protection theory: imperfect capital markets and appropriability.²⁴

The imperfect capital market problem is described as a situation where a developing country does not have a modern set of financial instructions that can transfer funds from a sector to another one,

¹⁹ BALDWIN, Robert E., "Openness and Growth: What's the Empirical Relationship?", in *Challenges to Globalization: Analyzing the Economics*, Baldwin and Winters, Chicago, University of Chicago press, 2004, pp. 499-521. p.516

²⁰ PACK, SAGGI, "Is There a Case for Industrial Policy?". p.272

²¹ HARRISON, RODRIGUEZ-CLARE, "Trade, Foreign Investment, and Industrial Policy for Developing Countries", p.4041

²² FUKASAKU, Kiichiro, MA, Yu, YANG, Qiumei, "China's Unfinished Open-economy Reform: Liberalisation of Services.", *OECD Development Centre Working Papers*, n. 147, Paris, OECD Publishing, 1999.

<https://doi.org/10.1787/110680138577>. P.19

²³ JENSEN, Camilla, "International Trade in Infant Industries: A Dynamic Analysis of Different Trade Policy Instruments and Their Implications for Sustainable Consumption." *Management Revue*, vol. 28, n. 1, 2017, pp. 121-148. JSTOR, <http://www.jstor.org/stable/26381573>. p. 141.

²⁴ KRUGMAN, Paul, OBSTFELD, Maurice, MELITZ, Marc, *International Economics: Theory and Policy*, New York, Pearson-Addison Wesley, 2022. p. 258

so the last one does not have the ability to grow. Authors stated that infant industry protection can be considered the second best solution, after the creation of a better capital market.²⁵

Appropriability is when a start-up company enters or creates a new market and takes the risks of its intangible outputs to be copied without any property right established. This phenomenon discourages firms to invest on new knowledge.

1.1.3 COMPARATIVE ADVANTAGE

We start with saying that there are some theories where it is believed that poor and not developed countries do not have any advantage, but this is completely untrue. Every country has that kind of industry in which it stands out. The theory also goes on saying that a country benefits from international trade by exporting its specialised product, elevating their consumption. This goes without saying that a government, in order to be successful, should invest in the industry where the comparative advantage is collocated. But why countries have in fact differences on comparative advantage? This is because of the difference on investments on resources across countries.

It is important to underline how this theory supports international trade and the opening-up of a market, while the previously presented theory of infant industry reveals the opposite view. Another advantage presented by comparative advantages is that of satisfy consumers' needs by increasing availability of goods, summing up both locally produced and exported ones, that usually have lower costs.

Speaking about costs and how they are influencing international trade, Schumacher (2013) underlines the fact that trade imbalances cause changes in exchange rates²⁶, so in order for a complete equilibrium to happen, export and import rates should be at the same level. This balance is relevant for the comparative advantage theory as it provokes the change from comparative production cost advantage to absolute price advantages, which is much more relevant to consumers.²⁷

From the classical theory to Neoclassical approaches, the comparative advantage concept changed perspective. While in David Ricardo's work we understand that the difference in comparative advantage depends on differences in technologies²⁸, the modern theory states that this technology can be transmitted to other countries and so potentially all countries have the same possibility to

²⁵ Ibid.

²⁶ SCHUMACHER, Reinhard, "Deconstructing the Theory of Comparative Advantage", *World Economic Review*, 2, 2013, pp. 83-105. p.87

²⁷ Ibid.

²⁸ Economic Commission for Africa, *Transformative Industrial Policy for Africa*, Ethiopia, 2016. p. 35

have this particular comparative advantage. However, researcher Ros (2001) argues that when we leave out the endowment factor, it is inevitable that specialisation will be influenced by the country's history and other initial conditions.²⁹

There have been discussions over the connection of industrial policy and the comparative advantage of a developing country. Lin (2009) sustains the idea of a continuous link between industrial policy and a given comparative advantage while Chang (2009) believes that development consists in the acquisitions of technologies through production, so comparative advantage should be ignored when talking about new industries or structural changes.³⁰

1.1.4 MARKET FAILURES

We have seen how, in recent years, free market actually led the world's economy into important crisis. Therefore, it is not wrong to state that to let markets play by themselves can cause pervasive problems and failures.

We describe market failure as a situation where distribution of goods and services is not sufficient in a free market. Hausmann and Rodrik (2006) divide the theme of market failure into two main problems: information spill overs and coordination failures.³¹ Another important topic that justifies government interventions on a country's economy where a situation of present market failures is the theory of information externality initiated again by the same authors.

Observing an innovative company, called "innovator" or "pioneer", that disseminates a new invention or discovery, other infant companies will receive the information and use it for their own purposes. This phenomenon constitutes a risk for the innovator because if it fails, the company has to bear all the losses. The authors also connect labour training as another possible information leakage. Labour mobility exists, and so a firm's ex-employees can export information to another firm.³²

²⁹ ROS, Jaime, "Industrial policy, comparative advantages and growth.", *Cepal Review*, n. 73, 2001, pp. 127–145. <https://doi.org/10.18356/aaa2aab6-en>. p.128

³⁰ LIN, Justin, CHANG, Ha-Joon, "Should Industrial Policy in developing countries conform to comparative advantage or defy it? A debate between Justin Lin and Ha-Joon Chang.", *Development policy review*, vol. 27, n. 5, 2009, pp. 483-502. <https://doi.org/10.1111/j.1467-7679.2009.00456.x> .

³¹ HAUSMANN, Ricardo, RODRIK, Dani, *Doomed to Choose – Industrial Policy as Predicament*, Cambridge, Harvard University, 2006. P.6

³² HAUSMANN, RODRIK, *Doomed to Choose...*, P.7

Andreoni and Chang (2019) dismantled this theory by describing it as an unfinished version of the infant industry argument.³³ They argue that information are firm-specific and so useless to other companies. Furthermore, these information are not transferrable.

While Haussmann and Rodrik (2006) suggest the use of subsidies to just the pioneer itself, Andreoni and Chang (2019) demonstrated that the government should help economically all the companies of a given industry. This is given to the fact that they ignored other factors and externalities that could let us understand that, in less industrialised economies, a general subsidy would have a greater effect.³⁴

To sum up, information externality problems do exist. The use of effective policies are justified by the fact that a firm or the entire sector might be affected by the circulation of information.

We should open a parenthesis on externalities concerning the environmental problem. A negative externality can be recognise where a firm does not respect the environment by polluting it and/or using damaging materials such as plastics. In case of missing intervention in order to disincentive its bad behaviour, the company of course will continue its activities without any problem. However, if the government recognises the problem and sanctions the company, encouraging the creation of positive externalities such as green transaction, the problem could cease.

The second problem concerning market failure is that of coordination failure. This is given to the fact that most investments in a certain industry require also an investment in connected industries. Rodrik (2004) suggest that coordination problems mainly arise when infant industries show scale economies and some of the inputs are cannot be transferred or require geographic vicinity.³⁵

Buera and Kaboski (2012) have recently underlined, through an empirical evaluation, the importance of coordination of technology, even if this will lead to an increase of costs.³⁶ Rodrik (2004) recalls this topic while talking about solutions for market failures. He states that government interventions should be focused on activities like a discovery of a new technology rather than on a certain new industry.³⁷

Examples of regulations mitigating market failures are those aimed to the maintenance of competition dismantling the monopoly system, a problem that we are going to discuss on the next chapters.

³³ ANDREONI, Antonio, CHANG, Ha-Joon, "The political economy of industrial policy: Structural interdependencies, policy alignment and conflict management.", *Structural Change and Economic Dynamics*, Vol. 48, 2019, pp. 136–150. <https://doi.org/10.1016/j.strueco.2018.10.007>. P. 139

³⁴ Ibid.

³⁵ RODRIK, *Industrial Policy for the Twenty-First Century*, 13

³⁶ BUERA, Francisco J., KABOSKI, Joseph P., "Scale and the origins of structural change.", *Journal of Economic Theory*, vol. 147, no. 2, 2012, pp. 684–712. <https://doi.org/10.1016/j.jet.2010.11.007>.

³⁷ RODRIK, *Industrial Policy for...*, p. 14

1.1.5 GOVERNMENT FAILURE

Government intervention is requested to correct market failures. However, government failures also happen, passively or actively. A passive government failure is defined as a lack of government to recognise the correct market failure, while an active government failure is defined when the outcome of government intervention makes the situation worse than the original market failure.

One of the most used argument against the application of industrial policy is the so-called “information constraint”, one of the typical demonstration of failure of a government.

Pack and Saggi (2006) suggest fifteen fields where policymakers should have some knowledge before implementing policies. Among them we note for example is to know which sectors have a long-term comparative advantage, the relative amount of learning by individual companies, and a forecast of which firms can create new knowledge and discover better production methods.³⁸ Just by analysing these three points we can understand that policymakers cannot have all these information, also because some of them are forecasts which can turn out to be wrong in the future. Supporters of industrial policy suggested that examples of the overcome of information constraints do exist, e.g. the case of Airbus and the solutions of the European Union.³⁹

Warwick (2013) adds another important consideration on this topic, saying that probably the effectiveness of a particular industrial policy depends on country’s political institution and system.⁴⁰ The idea is that a government should help firms taking into account economic merits and not political connections. Besides, a good government system should know that firms on different levels have different possibilities and capabilities. So to support large firms, that usually have better results, a better organisation and a bigger amount of resources, is a huge mistake.

When a government does not have enough information to intervene on market failures, economic actors may take advantage of the situation and act immorally. This may happen also on the other way: if an economic actor does not have enough information about a certain government request or intervention, it will not respect it as it should. Information must be clear and communicated in both ways, even if we recognise the difficulty of this transaction.

When the government decides to invest in a particular industry or sector, unluckily it is natural that some entrepreneurs try to persuade policymakers to favour their position by implementing tools that benefit their firm and/or can distort their market competition.

³⁸ PACK, SAGGI, “Is There a Case for Industrial Policy? A Critical Survey.”, P. 282

³⁹ NAUDE’, Wim, “Industrial policy: Old and new issues”, *WIDER Working Paper 2010/106*, Helsinki UNU-WIDER, 2010. P. 19

⁴⁰ WARWICK, “Beyond Industrial Policy: Emerging Issues and New Trends”. P. 23

Corruption is morally bad and it leads to two other problems. The first one is institution taking bribes to hire less qualified workers or not invest enough on projects. The second one is that bribes collectors attract more bribes collectors.⁴¹

There have been some evidences about bad industrial policies implemented just for personal interests, some scholars believe that corruption is one of the highest obstacles for an effective industrial policy. This phenomenon is present also among politicians themselves, putting aside national and societal interests. If we think about a specific policy aimed to different parts of a nation, we can easily recognise that different institutions that have an opinion and a role on its implementation may have different purposes and interpretations of the policy. Coordination of ideas is difficult to manage, so we best believe that different opinions are led by different dynamics, and not different personal objectives.

Many believe that this is one of the reasons why industrial policy is wrong, and the government interventions should be minimum. These failures are not natural, they are caused by individuals and so we best believe that the solution is to ameliorate the system morally rather than implement specific policies as we have seen for market failures.

As we have seen some basic concept that gave the foundation of the industrial policy discussion, we will understand how it influences competition, both locally and globally.

⁴¹ KEECH, William P., MUNGER, Michael C., SIMON, Carl, *Market Failure and Government Failure*, Miami, Paper submitted for presentation to Public Choice World Congress, 2012. p.19

1.2 THE ROLE OF COMPETITION

As previously said, industrial policy's main goal is to boost a country's industry in order also to increase GDP and other important indicators. Competition in the market has always been present, it is a basic concept since the first industrial policy theories appeared and the world opened its borders to a common and accessible market. But how influential are industrial policies in respect to international competition and trade?

It is a matter of fact that, as we have seen in the previous paragraphs, every country has its comparative advantages and it is natural that governments want its country to be the most competitive on these, boosting its economy to reach economic growth and development.

Under a world where competition is present, prices are given by the market and not controlled by a single firm. Different companies from different parts of the world and different supply chains set prices for its services and goods, even if sometimes influenced by government's policies to boost it. We can easily observe two situations: one where the market is extremely competitive and new firms can't enter the system, and the other where there is no rivalry. The intervention of industrial policy is essential when the adjustment of these situations is needed. In a free market, competition is essential, however, it is necessary to control it in order to keep it balanced and contrast monopolies. We are going to analyse in what terms do these rivalries happen and how they are hindered through industrial policies. Then, we broaden our vision by looking at how competition affects multinational trade. It is important also to consider differences in national competition laws of the countries and institutions we are analysing in this research, so we can face the competition argument with a much more specific vision of the countries we are going to consider on the next chapters of this thesis.

1.2.1 WHAT IS COMPETITION

Firms do not become top-tiers without any reason. Reasonably, we identify different justifications for a firm's position in the market, that can both be natural or not.

The first reason that comes to our mind is the structure of the market. The natural monopoly phenomenon exists when the monopolistic firm takes advantages of the economies of scale, and so

it reduces the costs it would have in a situation where competitors exist.⁴² Examples of natural monopoly can be those industries where unique raw materials are used, or unique technologies, that cannot be found in any other competitor.

Another justification for the position of a given firm on the market is simply the reaction of consumers. A firm can dominate the market simply because its product or service is better than its competitors'. This is a completely legit reason, since in this case the firm had nothing to do with its climb to power, it's a natural phenomenon that can happen in a free market. Sometimes we observe this is all about information. Consumers are not informed about competitors' product and services, so they judge a commodity as "the best" just because they are missing other information.

The opposite situation happens when a firm takes illegal actions to become the best in comparison to its competitors. We call it abuse of market power when a firm takes advantage of its position and gain an even bigger power. These abuses can affect both industrial competitors and consumers.

Di Tommaso, Rubini, Barbieri and Tassinari (2021) give us two important examples of firms sanctioned because of its abuses of power, namely Alibaba in China and Facebook in the United States.⁴³ We all know that these two platforms became top-tiers on their industry rapidly, surpassing every competitor that was trying to enter the market. However, both have been sanctioned for their unethical use of power, such unfair acquisitions and use of users' data for commercial use.

Antitrust offices and laws are also aimed to limit companies fusions and acquisitions since these actions can reduce competition. It is a matter of fact that when a bigger company acquires another smaller firm, clients and suppliers are mixed together. By doing this, the company who bought the smaller one will incorporate also its resources. Mergers and acquisitions are completely legal, but the aim of antitrust offices is to control whether this action will change the situation of the market and the company's competition.

Another situation where it is necessary to intervene to fix competition is when a company or a group of companies take actions that can influence the market. For instance, a firm can fix a very low price for its products or cartels that reduce drastically the competition. Prices can be fixed horizontally, and so firms operating on the same sector collaborate to reduce prices in different ways, for instance by establish common regulations or invest on technologies that could low prices.⁴⁴ Price regulations can also be vertically oriented, signing agreements where special channels of supply and access.

⁴² DI TOMMASO, Marco, RUBINI, Lauretta, BARBIERI, Elisa, TASSINARI, Mattia, *Economia e politica industriale. Organizzazione della produzione, innovazione e politiche di interesse pubblico*, Bologna, Il Mulino, 2021. P. 502

⁴³ Ibid.

⁴⁴ Ibid.

We can think about these situations both with a local point of view and an international point of view. Competition between firms from different countries are completely normal in the world we are living today, but are there any consequences for international trade?

Of course there are, and we are going to analyse the case of the Chinese solar panel industry later on this thesis. But before going through the topic, we must be aware of how countries' antitrust laws differ and their impact on today's global competition. These laws are extremely important, since they represent a link between economy and politics.⁴⁵ Needless to say they are also essential for the regimentation of the market, whether inside or outside the country.

The term "competition" became relevant not a long time ago, precisely with the globalisation and the support of free market policies. Especially after 1990s, the EU made a great effort to let every single member state to develop their own competition laws. In 1997, the International Competition Policy Advisory Committee (ICPAC) was created. The main goal of this committee was to sentence global antitrust problems, but was soon disbanded in 2000.

A step further was made with the foundation of the International Competition Network (ICN), where discussions over antitrust policies were made between 14 countries' jurisdictions. The group was founded in 2001 after a ICPAC report where the initiative was greatly supported.⁴⁶ The ICN is indeed a useful and important organisation, but as Sweeney (2009) stated, it is not made to solve all types of international competition problems.⁴⁷

1.2.2 ANTRITRUST LAW IN THE US

It is a matter of fact that American and European antitrust legislations are the basis of many young competition laws, such as China's. Their long history and successful implementation served as good examples and templates for developing countries that completed their antitrust laws on a later time because of their political framework or market size.

In fact, United States' competition deals have the *Sherman Antitrust Act* (1890), *Clayton Antitrust Act* (1914), and *Federal Trade Commission Act* (1914) as foundations. Let's analyse them briefly. The *Sherman Antitrust Act's* main purpose is to limit agreements between enterprises that can damage the competition in the market. At that time there were some extremely powerful

⁴⁵ GERBER, David J., "Economics, Law and Institutions: The Shaping of Chinese Competition Law.", *Washington University Journal of Law and Policy*, vol. 26, 2008, pp. 271–299.

https://openscholarship.wustl.edu/law_journal_law_policy/vol26/iss1/12. p. 275

⁴⁶ ICN, "About – ICN", 2022, <https://www.internationalcompetitionnetwork.org/about/>, (Accessed May 23, 2023)

⁴⁷ SWEENEY, Brendan, "International competition law and policy: A work in progress.", *Melbourne Journal of International Law*, vol. 10, no. 1, 2009, pp. 58-69.

corporations (e.g. tobacco and oil corporations) that had an immense influence on the market. At the beginning of its enforcement, little attention was given to its implementation, letting more than a company growing without any problem with the law.

Secondly, in order to regulate consumer's high costs given by the fact that corporations started to merge and control prices, the US congress decreed the *Clayton Act* in 1914, which was amended with some adjustments in the following years. During the same year, also the *Federal Trade Commission Act* was implemented, founding a Commission that had the aim to prevent unfair competition and police corporations that violate the act. This Commission shares enforcements with the Antitrust Division of the American Department of Justice.

Although these acts were implemented rapidly, their application was not so severe. In fact, Kovacic and Shapiro (2000) state that until 1930s American economists and officials were in favour of "associationalist", so actually they thought that collaborations between companies were good for the country's economy.⁴⁸

These above mentioned acts are considered the foundation of the concept of competition policy around the world, even if the US is considered also the promoter of the free market concept. From the 1970s, US antitrust policies' main goal is to protect consumers and the free market economy, but it is described by Fox (2009) as unfair and with a certain hostility towards concentration of economic power.⁴⁹ It has been observed that, since 1970s, American companies are more and more free on their business and anticompetitive moves have been frequently ignored by institutions. In particular, different tech companies from the United States visibly have gained power on the market acquiring competitors and using data to reinforce their position, but little actions have been taken.

Another important aspect to consider is the global reach of the US antitrust law. Even if, at the beginning of its jurisprudence, the connection with global competition cases was denied, it has gradually shifted to a much more attention to competition happening domestically but because of actions of a foreign company.⁵⁰

⁴⁸ KOVACIC, William E., SHAPIRO, Carl, "Antitrust Policy: A Century of Economic and Legal Thinking.", *Journal of Economic Perspectives*, vol. 14, no. 1, 2000, pp. 43–60. P. 46

⁴⁹ FOX, Eleanor, *The Competition Law of the European Union in Comparative Perspective: Cases and Materials*, West Academic Publishing, 2009. P. 340

⁵⁰ BRADFORD, Anu, *Antitrust law in global markets*, Research Handbook on The Economics of Antitrust Law, Einer Elhauge, Ed., Edward Elgar Publishing, 2012. <https://doi.org/10.4337/9780857938091.00020>. P.287

1.2.3 ANTITRUST LAW IN THE EUROPEAN UNION

Speaking about another influencing system when talking about competition law, after a long period of protectionism and focus on national champions, the EU member states started to think about a common competition law, also supporting the single market idea that was coming up during the 1950s. On 25th March 1957 the Treaty on the Functioning of the European Union (TFEU) was signed in Rome. This treaty includes Article 101 and Article 109 which delineate the EU competition law, the enforcement task was given to the European Commission. Article 101 aims to prevent and restrict those companies that distort the free market concept through fixing prices, imposing limits of production and/or investments, share markets or sources of supply etc.⁵¹ Article 102 is closely connected to Article 101, since it deals with abuses of power. It is important to underline that European Competition rules are assimilated in Treaty articles as in Council and Commission regulations, although their role here is merely models, they are not laws.⁵² Dissolutions of European Commission actions on competition cases are to be presented to the General Court, where the Court of Justice hears the appeals.⁵³

National authorities and local competition laws remained into force, while this common treaty refers to competition among the EU members. We mention here *Autorità Garante della Concorrenza e del Mercato*, founded in Italy in 1990, and *Bundeskartellamt*, which is Germany's competition regulator, established in 1958.

The problem was that as the European market was gaining recognition and was growing extremely fast, the workload was also increasing. To solve this problem, the EU Council Regulation 1/2003 came into force in 2004, giving National Competition Authorities (ECN) the possibility to conduct investigations on national cases and then enforce the EU competition law. ECN became the coordinators of these different codes, managing information and integrity of the whole system. As the two most influential antitrust law systems, the United States and the European Union do differ somehow also when considering this topic. Needless to say, one of the several reasons these American and European approaches are different is because they have different law orientations: the United States have common law as legal system, while the European Union refers to the civil law system. We underline other differences such as how they deal with cartels. In fact, the US

⁵¹ "Treaty on the Functioning of the European Union (TFEU)", The Faculty of Law, Oslo,

https://www.jus.uio.no/english/services/library/treaties/09/9-01/tfeu_cons.html#treaty-header2-9

⁵² CARREE, Martin, GÜNSTER, Andrea, SCHINKEL, Maarten Pieter, "European Antitrust Policy 1957–2004: An Analysis of Commission Decisions.", *Review of Industrial Organization*, vol. 36, 2010, pp. 97–131. <https://doi.org/10.1007/s11151-010-9237-9> p. 100

⁵³ ROMANOFF, Tom, "Comparison of Competition Law and Policy in the US, EU, UK, China, and Canada", Bipartisan Policy Center, 2021, <https://bipartisanpolicy.org/blog/comparison-of-competition-law-and-policy-in-the-us-eu-uk-china-and-canada/>, (Accessed May 25, 2023)

competition law considers cartels as a crime and imprisonment is expected; on the other hand, the EU competition law limits punishments with fine payments.⁵⁴ In addition to this, ECNs have the task to control mergers and acquisitions also between non-EU companies that have several operations in the European territory, while the US courts cannot. Moreover, in the US private enforcement is particularly relevant, whereas in Europe is much more limited.

It is also noticeable a higher domination globally of the European antitrust law, rather than of the American antitrust law. The European Antitrust law is newer than the American one, and so it aims better to problems affecting our modern society and market. Moreover, the European Antitrust law is precise and contains detailed rules, there is no space for interpretation, so it is much easier to comprehend and replicate.⁵⁵

1.2.4 ANTITRUST LAW IN CHINA

In China, the competition law has been discussed since 1993, but the law has been implemented only in 2008. This delay was mainly caused by the theory of the role of the market that governs CCP. In other words, it was believed that the government should lead the economy, not a law. This is pretty obvious for a country ruled by a centrally planned economic system, where the word “competition”, especially when in international connotations, is not well known. But since China started to switch to a market economy in late 1970s and then joined the WTO in 2001, it was necessary to meet the organisation’s requests. WTO does not oblige its members to implement a competition law, but it encourages it to avoid distortions of the market. Since China was becoming one of the most influential country of the world, and most of the developed countries had already implemented a competition law,⁵⁶ the Chinese politicians at that time started to outline a law that could also meet the country’s political system. The problem was that Chinese economists have never experienced anything like competition laws, so the solution was to ask for experienced foreign experts’ help, mainly American and European. However, at the end China adopted the European model, as its legislations are much more suitable for developing countries.⁵⁷

⁵⁴ FOX, Eleanor M., “US and EU competition law: A comparison”, *Global competition policy*, 1997, pp. 339-354. p. 342

⁵⁵ BRADFORD, Anu, CHILTON, Adam S., LINOS, Katerina, WEAVER, Alex, “The global dominance of European competition law over American antitrust law”, *Journal of Empirical Legal Studies*, vol. 16, 2019, pp. 731-766. https://scholarship.law.columbia.edu/faculty_scholarship/2513/ . p. 6

⁵⁶ Ibid.

⁵⁷ WANG, Jing, CAHILL, Dermot, “Legitimacy and effectiveness concerns in China’s private antitrust enforcement regime: a comparative analysis with the EU & US regimes”, *Journal of Antitrust Enforcement*, 2022, pp. 1–37. <https://doi.org/10.1093/jaenfo/jnac029>. p.4

Before 2008, discussions were less formal and regulations were not complete, but the most finalised version was implemented the year of the Great Economic Crisis and it was called *Antimonopoly Law* (AML). Started to be enacted in 1994, AML became a core concept on China's globalisation. With the new Chinese administration, AML got some revisions on June 2022.⁵⁸ One of the biggest changes was the exacerbation of fines violations: these got 10% higher than in 2008. Another significant change has been made by adding an article, correspondingly Article 9, which deals with the usage of technology, data and algorithms.

AML is carried out by the Anti-monopoly Enforcement Agency, the problem is that in China administrative agencies are not always clear on their job.⁵⁹ Moreover, China used to have three government agencies: the Ministry of Commerce Anti-Monopoly Bureau (MOFCOM), the Anti-Monopoly and Anti-Unfair Competition Bureau of the State Administration of Industry and Commerce (SAIC), and the National Development and Reform Commission (NDRC). MOFCOM was in charge of mergers control, SAIC of violation of non-price violations and NDRC was responsible of price-related violations of the Antitrust law. It is understandable that this subdivision of specialisations was extremely confusing. In 2018, the Chinese government merged these institutions into a single one, called State Administration for Market Regulation (SAMR). MOFCOM and NDRC are still present but without any power, while the SAIC was completely integrated.

Even if we are aware of the fact that Chinese competition law is influenced by American and European ones, there are some differences often dictated by political differences. For instance, Chinese antitrust law may be particularly damaging for American companies who want to join a Chinese company because pre-merger notifications must have parties' total sales in China written, and not only links with transactions in China.⁶⁰ Actually AML Chapter 1 Article 2 states that the law should be applied within the PRC and to activities outside its territory that have repercussions on the domestic market of the PRC.⁶¹

So, the Chinese Antitrust law since the very first draft has included general monopolistic behaviours, giving for granted that foreign companies operating on the Chinese market were also included on the regulation and should be punished as any other local company.

⁵⁸ Guojia shichang jian du guan li zong ju 国家市场监督管理总局, *Zhonghua renmin gongheguo fanlongduan fa 中华人民共和国反垄断法* (Anti-Monopoly Law of the People's Republic of China), 2022, https://gkml.samr.gov.cn/nsjg/fgs/202211/t20221102_351257.html

⁵⁹ OWEN, Bruce M., SU, Sun, ZHENG, Wentong, "China's Competition Policy Reforms: The Anti-Monopoly Law and Beyond", *Antitrust Law Journal*, 2008. <http://scholarship.law.ufl.edu/facultypub/223>. p. 241

⁶⁰ FARMER, Susan Beth, "The Impact of China's Antitrust Law and Other Competition Policies on U.S. Companies", *Loy. Consumer L. Rev.*, 2010, pp. 34-53. p.36

⁶¹ Anti-monopoly Law of the People's Republic of China, art. 2, available at http://www.china.org.cn/government/laws/2009-02/10/content_17254169.htm

Another problem with the Chinese regulation is that of SOEs favouritism. In fact, Chinese SOEs are defined in AML as “business operators” but they are submitted to different standards.⁶² This topic has been one of the greatest obstacles of AML drafting, however the tendency is that of Chinese government to incentivise competition also among SOEs, dismantling them into smaller enterprises and introducing these companies in sectors where they can compete with private firms.

1.2.5 COMPETITION IN THE INTERNATIONAL TRADE

If we look at the competition concept in a broader way, we define international competition as a practice aimed to get the best prices of goods and services. It is a simple game between demand and supply: when demand is huge, prices tend to get higher, on the other hand when demand goes down costs of goods also go down. Every company’s goal is to offer the best goods or services at the best price, in order to be competitive in the market. Taking an international point of view, we classify two types of international trade competition: direct and indirect. Direct competition is when more than a firm offer the same product or service to the same market. We call it indirect competition when different firms offer different goods or services to the same market.

WTO covers a fundamental role on its members’ trade regulation. The WTO’s mission is basically focused on keeping markets open with some rules that cover also competition. In fact, even if every country has its own competition law, it is fundamental to have some principles in common, in order to avoid clashes. However, a common framework does not exist, there are some agreements that recognise the need to take actions against competition clashed, namely the Agreement on Trade-Related aspects of Intellectual Property Rights (TRIPS), and the Agreement on Trade-Related Investment Measures (TRIMS). The WTO presents thirty agreements on trade, intellectual property and resolutions for state disputes, but does not standardise a common competition law for private entities. Actually, the establishment of a common antitrust law was on the 2001 Doha round agenda, but the organisation soon abandoned the idea.

If we evaluate a comparison with trade laws, it is noticeable how they differ. National trade laws are much more incorporated than national competition laws, litigations between two different laws are discussed by international tribunals.⁶³

⁶² FARMER, “The Impact of China’s Antitrust Law”. P.39

⁶³ ABBOTT, Alden F., SINGHAM, Shanker, “Competition Policy and International Trade Distortions.”, in *European Yearbook of International Economic Law 2013*, Herrmann, C., Krajewski, M., Terhechte, J. (eds.) *European Yearbook of International Economic Law*, vol 4. Springer, Berlin, Heidelberg, 2013, pp. 23-37. p. 23

There are different reasons why it is difficult to define a single competition policy for every single country. Several aspects, for instance the level of development, the type of government, culture, interpretation of laws, drive different views over these laws. However, we can see why the US and the EU do attempt to replicate their antitrust regulation to other countries. A similar, or completely equal, competition system would reduce entry and/or transaction costs, this is also because interpretation of them is not needed and exchanges would be easier.

Despite these differences between countries, the Organisation for Economic Cooperation and Development (OECD) seems to have made the difference in the world's competition code. This international organisation has done a great work in terms of international cooperation, even on a continuously changing world. OECD differs from ICN by the fact that it does not concern antitrust policies alone, but also other different policies.⁶⁴ The ICN has a 15 members committee that changes every two years and holds a conference every year after consultations with both state and non-state participants.

Another important international antitrust institution is the United Nations Conference on Trade and Development (UNCTAD), sponsored by the United Nations and aiming at trade in developing countries. The problem with UNCTAD is that its agenda is formed by developed countries, rather than developing ones.⁶⁵

1.2.6 COMPETITION & INDUSTRIAL POLICY

Are competition laws and industrial policies complementary in some ways? Researcher Petropoulos (2019) claims that the two are essentially complements and should coexist.⁶⁶ He goes on stating that market imperfection led by competition might come out, and here the industrial policy shows its essential role, because it induces investments to let companies to innovate. These are affected by competition in a sense that they are continuously innovating to be competitive on markets.⁶⁷

Kroes (2006) also supports the idea of coexistence of industrial policies and competition policies, that is because the aim of competition laws is to maintain competition on markets, and so is central

⁶⁴ SWEENEY, "International competition law and policy: A work in progress."

⁶⁵ SOKOL, D. Daniel, "The Future of International Antitrust and Improving Antitrust Agency Capacity", *Northwestern University Law Review*, vol. 103, 2009, pp. 1081-1096. p.1084

⁶⁶ PETROPOULOS, Georgios, "How should the relationship between competition policy and industrial policy evolve in the European Union?", Bruegel, 2019, <https://www.bruegel.org/blog-post/how-should-relationship-between-competition-policy-and-industrial-policy-evolve-european>, (Accessed 20 May 2023)

⁶⁷ Ibid.

for industrial policy, which main goal is to enhance industrial competitiveness.⁶⁸ However, Brooks (2007) believes that conflicts between the two exists particularly in different periods and when foreign entities enter to the local market.⁶⁹ He goes on saying that the main driver of conflicts in time frames is the IRP protection, a relatively recent but extremely important right that gives a firm a particular characteristic. If we analyse it on the short run, we find it is necessary to protect a company's trademark in order to alter competition and appear to the market as something unique and bigger than its competitors. But when we think of it in a long term sense, the company can be take a monopolistic position, but letting competitors to innovate and thus let them compete with new and upgraded products or services.⁷⁰

It is after the collapse of the economy in 2008, and the consequent change on the idea of industrial policy that ideas on competition did also change.

Aghion, Dewatripont, Du, Harrison and Legros (2015) also sustain the idea of complementarity between industrial policy and competition, as within-sector competition encourages innovation to avoid it.⁷¹

On year 2010, the EU underlined its support to industrial policies, competition and trade as pillars of economic growth, by stating:

*“An ambitious strategy framework for a new industrial competitiveness policy must put the competitiveness and sustainability of European industry at centre stage [...]”*⁷²

(European Commission)

The COVID-19 pandemic has underlined the interconnection between competition and industrial policy, demonstrating also different levels of conflict between the two. A recent report from UNCTAD (2023) demonstrated that interventions on competition helped the efficiency of industrial policies.⁷³ Authorities should work together to reinforce collaboration between the two.

⁶⁸ KROES, Neelie, “Industrial Policy and Competition Law and Policy.”, *Fordham International Law Journal*, vol. 30, no. 5, 2006, pp.1401-1412. <http://ir.lawnet.fordham.edu/ilj>.

⁶⁹ BROOKS, Douglas H., “Industrial and Competition Polity: Conflict Or Complementarity?”, *ADB Research Policy Brief*, no. 24, 2007. P. 5

⁷⁰ Ibid.

⁷¹ AGHION, Philippe, DEWATRIPONT, Mathias, DU, Luosha, HARRISON, Ann, LEGROS, Patrick, “Industrial Policy and Competition”, *American economic journal: macroeconomics*, vol. 7, no. 4, 2015, pp. 1-32. <https://doi.org/10.1257/mac.20120103>. P. 3

⁷² European Commission, “Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - An Integrated Industrial Policy for the Globalisation Era. Putting Competitiveness and Sustainability at Centre Stage”, EUR-lex, Brussels, COM (2010) 614, 2010, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52010DC0614>

⁷³ UNCTAD, *Interaction between competition and industrial policies*, April 26, 2023, TD/B/C.I/CLP/69, https://unctad.org/system/files/official-document/ciclpd69_en.pdf

To sum up, we consider through this thesis that competition and industrial policy should complete each other and cannot be separated. Later on this concept will be even more accentuated, with green economy influencing both of them.

1.3 THE GREEN ECONOMY

Importance of the green economy became bigger during the last century. Indifference towards the world we are living in, and not only, made its dangerous effects visible to us through climate change, deforestation, extinction of different species and so on. Our development model has failed to keep an eye on our surroundings, it is time to change perspective and take a path that can lead us to a much more sustainable model to reach economic growth and development.

Luckily and, we can say, finally, we are getting more and more conscious about the crisis we are living in, less luckily because of continuous natural disasters happening in own world. People are much more aware of consequences on our planet: discussion and concrete actions are increasingly relevant in our society and economy. Even if sometimes economic goals prevail on environmental goals, we observe a general tendency also on companies towards a more sustainable production. It is important for firms to invest on technologies and instruments that can reduce the impact on the environment of it. In fact, actions must be taken not only by individuals, but also at the industry level, where actually a huge part of our world's pollution comes from.

Green industrial policy is a relatively new concept introduced after the discovery of connection between economic actions and the planet. Generally speaking, the EU is extremely devoted to this concept, especially Scandinavian countries more than Southern ones. China and the US, namely the most polluting countries of the world, are also taking small and slow, but important steps to overcome and alleviate sustainability in the economy. But unfortunately, most countries are taking into consideration green policies just to reach an economic advantage, more than because of their real interest on the problem.

We are going to analyse how the concept was born and the main theories of its implementation. It is important also to know theories against it and how they can influence the government.

Subsequently we are going to answer the questions on how green economy is connected to industrial policy and competition. Finally, considerations over the future of green economy are made, especially taking into account some important crisis we have, and still are, facing.

1.3.1 BIRTH OF THE CONCEPT

The green economy is a relatively recent notion that implies a better use of resources and reach economic growth and development while also taking care of the environment. However, this is considered an “umbrella” concept, since we can interpret it in various senses and fields.⁷⁴

The concept of green economy was first introduced by Pearce in 1989 in his book “*Blueprint for a Green economy*”, analysing the societal and environmental costs of those years’ economic systems and policies with a neoclassical point of view.⁷⁵

An important step for the green economy concept was made in 1992 during the United Nations conference on Environment and Development (UNCED) in Rio de Janeiro, also known as Earth Summit. Here was discussed the reactivation of the economy after the Cold War, and for the first time sustainability was mentioned, especially production of toxic materials, air pollution and the importance of water, which is still a limited resource. The conference was held a second time in 2012 (UNCSD, also known as Rio+20), where measures for sustainable development were discussed, there were also adopted green policies that are still in action nowadays. Afterwards, the United Nations Framework Convention on Climate Change (UNFCCC) was signed and established, giving responsibilities to the signatory members to participate and follow diverse conventions and policy agreements over climate change. The first implementation of these measures was the Kyoto Protocol, signed in 1997 and implemented from 2005 to 2020. Subsequently it was replaced by the Paris Agreement in 2016, which did not present a huge difference on goals between developing and developed countries. Agenda 21 is another non-binding plan signed by 178 nations in 1992.

Going behind on history, the UN Environment Programme (UNEP) was founded in 1972 and since then it establishes different environmental agendas for the UN members. Nevertheless, the green economy concept began in 2008 as a Global Green New Deal in the US, where suggestions were proposed to fight climate change and promote a sustainable growth. Europe also established an European Green Deal in 2020 to reach climate neutrality by 2050.

Recently, the UN published “The 2030 Agenda” which serves as a plan of green activities for people, planet and prosperity.⁷⁶ The plan was signed by 193 countries.

⁷⁴ LOUSEAU, Elenore, SAIKKU, Laura, ANTIKAINEN, Riina, DROSTE, Nils, HANSJÜRSENS, Bernd, PITÄKEN, Kati, LESKINEN, Pekka, KUIKMAN, Peter, THOMSEN, Marianne, “Green economy and related concepts: An overview.”, *Journal of Cleaner Production*, vol. 139, 2016, pp. 361–371. <https://doi.org/10.1016/j.jclepro.2016.08.024>. P.362

⁷⁵ Ibid.

⁷⁶ United Nations, “Transforming our world: the 2030 Agenda for Sustainable Development”, United Nations, 2015, <https://sdgs.un.org/2030agenda>

These are just some of the international agreements about the amelioration of our world's environment. Governments from different countries with different cultures and ideas continue to meet each other on the willingness of common prosperity and on the awareness that we should all work together to fight climate change and build a more sustainable economic system that do not waste resources.

But why green economy? It has been demonstrated that production impacts also a country's GDP. The more the environmental impact, the less GDP growth. So green economy is not just about environmentalists, but also it has its origins on the economy itself. This idea was particularly relevant after the 2008 global financial crisis and the launch of the Green Economy Initiative by UNEP, an initiative to support investments on green sectors and amelioration of others. It was understood that climate change and economic recovery were not so distant.

Green economy is defined as based on the concept of the three pillars of sustainability: economic viability, environmental protection, and social equity. This concept was first mentioned by Brundtland report in 1987 and there have been several discussion over it until recent years.⁷⁷ The economic pillar represents profit while also taking into account the impact of economic activities. To alleviate economic impact on planet earth, government regulations are used. This pillar is also connected to the increase of awareness on new sustainable business activities, that are often financed by the government itself. Then the environmental pillar is a set of regulations, laws, etc. which deal with environmental issues for instance lack of water, forest, wildlife and other issues. An example of environmental protection could be incentives to firms and private holders to switch to renewable energy sources. Lastly, the social pillar is much more complicated to define and implement in a real society. The social pillar refers to those actions which goal is to fight poverty, promote equality, etc.

So we can conclude by saying that the green economy is a large and complicated concept. In this essay we are going to focus on the economic aspect of it.

1.3.2 CRITIQUES AGAINST THE GREEN ECONOMY

The idea of an economic growth and development through the safeguard of nature and biodiversity is obviously captivating, but is it really possible to support both capitalism and environment needs?

⁷⁷ PURVIS, Ben, MAO, Yong, ROBINSON, Darren, "Three pillars of sustainability: in search of conceptual origins", *Sustainability Science*, vol. 14, 2018, pp. 681-695. <https://doi.org/10.1007/s11625-018-0627-5>. P.684

Criticisms have been raised over the existence and effectiveness of the green economy, specifically analysing both our current economic model and environmental situation.

Several researches and predictions have been made to better demonstrate why the concept of green economy has some deficiencies. For instance, a prediction over the possibility of decreasing the use of natural resources was first made by a team of researchers led by Ditttrich et al. in 2012.⁷⁸ It was found out that actually the use of resources would increase instead of decrease by 2050.⁷⁹ We can interpret this result as the impossibility for us to completely decouple from natural resources. Also, it is reasonable to think that not every single country would do the same effort to reach a certain level of natural consumption, also considering economic interests.

Another critique was made by Wilson (2019), who describes five fundamental problems that green economy does not aim at. These are:

1. Ecosystem services are difficult to price;
2. Insufficiency of the consideration of the rebound effect;
3. Obvious primacy of economics over the environment factor;
4. Little protection for the poorest people;
5. Not successful market mechanisms aimed at safeguarding the environment.⁸⁰

Ecosystem services are namely those benefits that serve society such as reduction of air and water pollution. The solution proposed by UNEP is basically to eliminate externalities and move funds to providers of these. The thing is that these resources are impossible to be monetized, thus the risk is that we may not cover even half of the problems on ecosystem services.

The second problem arose by Wilson (2019) is the rebound effect. The rebound effect appears to happen when the amelioration of use of natural resources inevitably leads to an increase of use of different technologies and other different natural resources.⁸¹ It is reported that in the UNEP report there is no solution to this problem, which of course should be solved as soon as possible.

A report drafted by a working group named “Societal relationships with nature” of Bundeskoordination Internationalismus (2012), listed ten thesis against green economy.⁸² Some of

⁷⁸ DITTRICH, Monika, GILJUM, Stefan, LUTTER, Stephan, POLZIN, Christine, *Green Economies Around the World?: Implications of Resource Use for Development and the Environment*, Sustainable Europe Research Institute (SERI), Vienna, 2012. p.67

⁷⁹ Ibid.

⁸⁰ WILSON, Mark, “The Green Economy: The Dangerous Path of Nature Commoditization.”, *Consilience: Journal of Sustainable Development*, no. 21, 2019, pp. 86–99. <https://www.jstor.org/stable/26775085>. p. 88

⁸¹ Ibid.

⁸² Working Group ‘societal relationships with nature’ (GesNat) of the Federal Coordination of Internationalismus (Bundeskoordination Internationalismus – BUKO), *After the failure of the Green Economy – Ten theses of a critique of the Green Economy*, BUKO, 2012, <http://rio20.net/en/documentos/ten-theses-of-a-critique-of-the-green-economy/>

them coincide with Wilson's ones. Interesting and important to point out is thesis 8, which takes into consideration social discriminations on green economy. Unfortunately, the green economy does not include every single country of the world and for sure affects different countries in different ways. As we said before, it is impossible that policies and results would be equal everywhere.⁸³

This is given to the fact that every country has different resources, types of management, levels of development, etc. Also, it is obvious that a country where natural resources like fossil fuels are abundant would be deeply affected by restrictions over the use of these materials.

We should also consider the difficult transition from polluting resources to actually green ones. For instance, to try and eliminate completely the consumption of fossil fuels is not impossible, but it requires a huge amount of time and investments that not everyone has the mentality and the correct resources to do. For instance, we can observe that this phenomenon is present on the electric cars industry. It is because of incentives that their consumption is valid and convenient, but we are still too dependent on non-electric cars. And even if we completely change all cars into electric ones, the problem will shift from consumption of fossils and gasoline, to the use of other natural resources such as lithium and copper.

To sum up, should we support green economy initiatives or not? We have observed that there are different reasons to believe that green economy and all the actions that this new scheme present do have some lacks. Nevertheless, we cannot continue with our current system. We are not doing enough to help our planet and our future generations. Governments and institutions should keep on with collaborations and investments on R&D to overcome these lacks and build a better green economy, before it is too late.

1.3.3 GREEN INDUSTRIAL POLICY

As we previously said, it is time to make economic growth more sustainable. In order to do so, industrial policy can be an efficient instrument to guide industries through the change.

Green industrial policy has the same economic goals as to a more general industrial policy that we have described above: to increase opportunities of growth for national industries and implementation of employment.⁸⁴ This implies that also when talking about green industrial policies, governments are often called to pick companies and target resources by taking some risk. Another meeting point with the industrial policy concept is the long-term goal. We can reasonably say that it

⁸³ Ibid.

⁸⁴ HALLEGATTE, Stéphane, FAY, Marianne, VOGT-SCHILB, Adrien, "Green Industrial Policies: When and How." *World Bank policy research working paper*, 2013. <https://doi.org/10.1596/1813-9450-6677>. p.3

is impossible to achieve great environmental results in a short period of time, therefore green industrial policies are to be thought as a mean to reach benefits in the future and for the future generations. As for other aspects, not every single country really support the green transaction, but it is visible a general positive involvement in both developed and developing countries, besides their idea on government intervention on the market.

There are several types of green policies already implemented around the world, later on in this essay we are going to deeply analyse those aimed to boost solar photovoltaics. Most generally speaking, we can evaluate R&D grants, government subsidiaries and loans as the mainstream policies to increase green growth. Rodrik (2014) gives us the useful example of Germany.⁸⁵ German government invested a huge sum in R&D grants, guaranteeing long-term low-interest loans to those industries concerning renewable power, and funds for the climate. The author then underlines the fact that we still do not know if these policies are effective or not, since all these have long-term goals, but again we say that industrial policies are all on speculation, and this is valid also for green ones.⁸⁶

As Hallegatte et al. (2013) underline, green growth needs a lot of research and training.⁸⁷ Because the instruments we have now are not as efficient as they should be in order to substantially influence the green transaction, investments should be huge and thought as something that should last for a long period of time. Lacks of funds are to be found where there is a misinformation between the government and a firm, which fears information leaking.⁸⁸ This phenomenon not only slows down green growth, but also economic growth.

Writer Van Reenen (2023) states that green industrial policy is all about market failures caused by climate change⁸⁹, and if we follow our analyses of market failures above, industrial policies are needed to solve them.

The Green New Deal is an important plan first drafted by the US and then also approved by the EU and other countries where policies aimed to climate change are proposed. The plan was designed during the 1990s, but was promoted as a recovery plan after the 2008 financial crisis. However, even if different countries positively agreed with the Deal's targets, Barbier (2016) gives us the evidence that policies proposed on the plan were not always respected. For instance, in 2009 only

⁸⁵ RODRIK, Dani, "Green industrial policy.", *Oxford Review of Economic Policy*, vol. 30, no. 3, 2014, pp. 469–491. <https://doi.org/10.1093/oxrep/gru025>. p. 473

⁸⁶ Ibid.

⁸⁷ HALLEGATTE et al., "Green Industrial Policies: When and How." p.8

⁸⁸ Ibid.

⁸⁹ VAN REENEN, John, "The Case for Green Industrial Policy", ProMarket, 2023 <https://www.promarket.org/2023/02/14/the-case-for-green-industrial-policy/>, (Accessed May 30, 2023)

four countries, China included, respected the investment required of 1% of GDP on green growth.⁹⁰ Attempts were also been made by WTO, stating in the Doha Agenda that tariffs should be eliminated, or at least reduced, for those firms producing environmental goods and services. Despite this, no classification of green products has been compiled, because of the difficulty to actually define what is green and what is not.⁹¹

1.3.4 GREEN GROWTH AND COMPETITION

Green competitiveness is a relatively new concept, but after 2008 it gained two different definitions. The first one is about national companies and the maintenance of competitiveness between trade-exposed industries. The other definition is much more international and is about competitiveness between countries on promotion and investments on green growth.⁹²

When talking about international competitiveness, it is necessary to compare different policies and their impact on industries. However, there is no official measurement yet, so comparisons are made through empirical data rather than researches.

Are competition laws a support or an obstacle to green transaction? In September 2020 the topic was first raised by the Executive Vice-president Margrethe Vestager. After numerous discussions and exchanges of ideas, some conclusions were proposed. The role of competition policies is extremely crucial, and so it is believed to impact every aspect of the market. In order to incentivise firms to take green initiatives, market distortions must be made. The European Commission makes the example of EU antitrust rules to help firms in this way.⁹³ Fotis (2021) also underlines the connection between the two by stating that the role of competition laws is to enhance green growth.⁹⁴ Moreover, national competition authorities' control over externalities and costs should help sustainability.⁹⁵

⁹⁰ BARBIER, Edward, "Building the Green Economy.", *Canadian Public Policy-analyse De Politiques*, vol. 42, no. S1, 2016, pp. S1–S9. <https://doi.org/10.3138/cpp.2015-017>. S2

⁹¹ WTO, "Eliminating trade barriers on environmental goods and services", WTO, https://www.wto.org/english/tratop_e/envir_e/envir_neg_serv_e.htm

⁹² FISCHER, Carolyn, "Green Competitiveness.", Prepared for the 8th Annual Research Conference of the European Commission DG of Economic and Financial Affairs, 21st November 2011, https://ec.europa.eu/economy_finance/events/2011/2011-11-21-annual-research-conference_en/pdf/session032_fischer_en.pdf

⁹³ BADEA, Alexandra, BANKOV, Marin, DA COSTA, Graca, et al., "Competition policy in support of Europe's green ambition.", *European Commission Competition Policy Brief 1*, 3, September 2021.

⁹⁴ FOTIS, Panagiotis N., "Sustainable Development and Competition Policy.", *Energy Research Letters*, vol. 1, no. 4, 2021. <https://doi.org/10.46557/001c.18578>. p.3

⁹⁵ Ibid.

Another point of meeting is when a company takes some important green innovation and has to face competition. Lübbig (2013) noticed that if competitors are not embracing green development as this given firm, this has to rely on consumers to communicate and keep its high value.⁹⁶

Maximiano (2023) writes on *Politico* that the green transition can be successful only where competition is present, because costs would be reduced.⁹⁷ However, there is no clear regulation about competition regarding sustainability, as the debate goes around the idea that the fight against climate change has a certain priority in different countries' agendas.

Many believe that exceptions should be made for companies that are sources of new green technologies. This happened in Germany, where the government does not apply competition law resolutely and introduced some subsidies for small companies working on renewable energies. The case of Preussen Electra, an important German energy company that complained that the law was against EU competition laws, was further discussed in the European Court of Justice (ECJ), which valued the case stating that the law was actually violating the provisions, but it was doing it for the sake of the environment.⁹⁸

To sum up, it has been demonstrated that green development and competition policies are complementary, at least in the EU point of view and competition is essential if not harmful and unfair.

1.3.5 FUTURE OF THE GREEN ECONOMY

Is green economy destined to be our goal forever? In a continuously changing world, it is practically given for granted that changes on this field are needed. It has been said over this chapter that green development trends are evolving and results of current policies will be visible in, we hope, a recent future. What is sure by now is that we are living in an era of “polycrisis”. This term is to define a period of time where different crisis emerge, and this is actually the world where we are living in. A new global pandemic, climate change and resulting natural disasters, frequent disputes between different countries (e.g. China-U.S., Russia-Ukraine), and extreme politics. But what is

⁹⁶ LÜBBIG, Thomas, “Sustainable Development and Competition Policy.”, *Journal of European Competition Law & Practice*, vol. 4, no. 1, 2013, pp. 1-2. <https://doi.org/10.1093/jecclap/lps073>. P.1

⁹⁷ MAXIMIANO, Ruben, “Without competition, the green transition will wither on the vine”, *Politico*, 2023, <https://www.politico.eu/article/competition-green-transition-us-eu-commission-trade-net-zero-industry-act-ira/>, (Accessed June 17, 2023)

⁹⁸ GEHRING, Markus W., “Competition for Sustainability: Sustainable Development Concerns in National and EC Competition Law.”, *Review of European Community and International Environmental Law*, vol. 15, no. 2, 2006, pp. 172–184. <https://doi.org/10.1111/j.1467-9388.2006.00519.x>. P.182

interesting to observe is that there is an increasing awareness on these events, therefore people are starting to extrapolate opportunities on these.

It is noticeable that different countries are dealing in different ways with sustainable development. Here below a map showing the level of change in renewable energy generation in 2021.

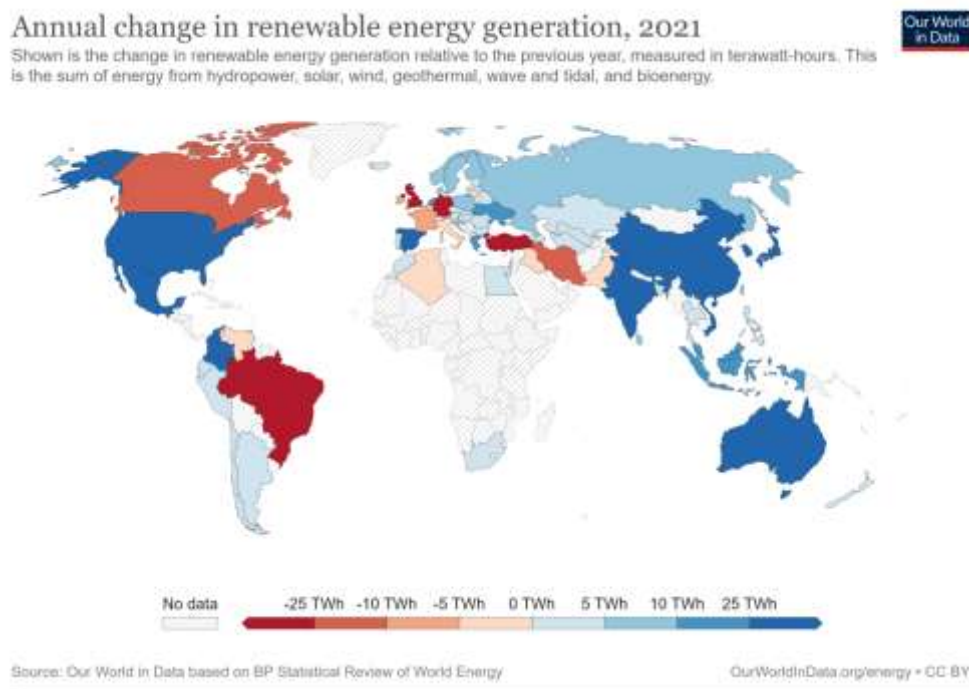


Figure 1 source: Our World in Data⁹⁹

Since fossil fuels are responsible for the majority of air pollution, one of the goals outlined by different countries and organisations is the gradual shifting from fossil fuels to renewable energies. Different countries are substituting source of energy in different velocities. An outstanding result is China, which passes from 459TWh in 2008 of change in renewable energy generation, to 706TWh in 2021. This value becomes greater when compared to other countries' results. The US was change was 162WTh in 2021, Italy 0WTh, while Germany closed in negative, with -42TWh.¹⁰⁰ Later on this essay we are going to analyse different policies and incentives of these countries to promote solar power production and consumption, and we are going to understand why there are these huge differences in data.

Another tendency of these years is the attempt to become more energy independent. This goal has been particularly relevant since the start of the Russia-Ukraine war in 2022. Reports show that in 2020, the EU imports of energy consumed accounted for 58%, and most of it was supplied by

⁹⁹ RITCHIE, Hannah, ROSER, Max, ROSADO, Pablo, "Energy", Our World In Data, 2022,

<https://ourworldindata.org/energy>

¹⁰⁰ Ibid.

Russia.¹⁰¹ A study conducted by Krane and Idel (2021) shows that if we invest more on renewable energy and we substitute fuels with it, we will be much more energy independent. As a consequence, risks of mining, trade and political disputes are reduced, the only dependence we may have is that of materials or components trade.¹⁰² If it is true that the EU imposed sanctions to Russia, and it was more a political move rather than aimed to switch to renewable energy, and moved its imports from the US, EU countries are still too dependent on fossil fuels.

If we look at the Chinese scenario, its major imports of oil and coal come from Saudi Arabia and Russia. However, the country is planning to focus on renewable energy and become more energy independent before 2025. This particular case and how China is dealing with the green transition is to be discussed in the next chapter.

Another worth mentioning concept is Industry 4.0, also called Fourth Industrial Revolution. The main goal of this Revolution is the digitalisation and the networking of the production system, taking into account every single aspect of it.¹⁰³ Industry 4.0 and sustainability are increasingly linked, as we observe that one of the main goals of this revolution is to make industrial processes more sustainable. There are three aspects where these two tendencies meet up: technological, process and development.¹⁰⁴ The technological level is a classic one. In order to develop new green strategies, we need technology and innovation. Since Industry 4.0 is led by digitalisation of the activities, it is easy to think about the connection with the creation of new sustainable resources. Industrial processes amelioration and minimising industrial waste are both goals of Industry 4.0 and green development.

We have seen what we define as industrial policy in recent years, what is its linkage with competition and the rising of the green economy. On the next chapter we are going to analyse how these concepts are interpreted and implemented by the Chinese government.

¹⁰¹ Eurostat, “The EU imported 58% of its energy in 2020”, Eurostat, 2022, <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220328-2>, (Accessed May 12, 2023)

¹⁰² KRANE, Jim, IDEL, Robert, “More transitions, less risk: How renewable energy reduces risks from mining, trade and political dependence.”, *Energy Research and Social Science*, vol. 82, 2021, pp. 1-11. <https://doi.org/10.1016/j.erss.2021.102311>. P.1

¹⁰³ WACHNIK, Bartosz, KLODAWSKI, Michal, KARDAS-CINAL, Ewa, “Reduction of the Information Gap Problem in Industry 4.0 Projects as a Way to Reduce Energy Consumption by the Industrial Sector.”, *Energies*, vol. 15, no. 3, 2022. <https://doi.org/10.3390/en15031108>.

¹⁰⁴ Luca CHIUSELLI, “Industry 4.0 and Green Economy: Solutions”, Esa AutomatioN, 2021, <https://www.esa-automation.com/en/industry-4-0-and-green-economy-solutions/>, (Accessed May 12, 2023)

2.1 INDUSTRIAL POLICY IN CHINA

We have seen the recent discussion over industrial policy and how the trend has changed from “should we apply industrial policy?” to “how do we best use it?”. This debate touched also China, a country that has only relatively recently opened to a market economy. China’s economy has gone through an interesting and unique path, merging both socialist and capitalist aspects on its policies. Since Deng Xiaoping’s *gaige kaifang* (改革开放), China became increasingly important and it is now the second most powerful country in the world. This phenomenon is not casual. Besides good policies and a detailed organisation of the industry, China, as any other country, has some particularly characteristics and circumstances that helped its rise to the world, as described by Kroeber (2020). Firstly, experiences from the neighbours like South Korea and Japan were used as templates to policies in the domestic market. Secondly, the important trading hub and port of Hong Kong helped Chinese firms to access easily to global trade. Thirdly, China opening reform was implemented right when the whole world was starting to facilitate its global production chains through new inventions such as containers. Last but not least, Taiwan became an important electronic industry which then moved its production to China in the 1990s, and helped the development of the industry in mainland China.¹⁰⁵

The entrance to the world’s economy led the country to face some significant issues. Conflict over politics became also economic problems and vice versa. China has been described several times as “the world’s factory” and we observe that actually at the beginning of its opening the situation was like this. But as China is becoming increasingly influent and foreign investments are moving to countries where manufacturing is cheaper, such as Mexico and India, shall we still consider China as a mere producer? In fact, China is changing its policies, focusing on the internal market and reducing its dependence on foreign investments and exports.

Moreover, China is the most polluting country in the world, with more than 9.9billion tons of CO₂ emissions in 2020. The United States, which follow China as the second most polluting country in the world, in 2022 emitted 4.4billion tons of CO₂.¹⁰⁶ It is easy to see through these data what is China’s impact on our planet. Fortunately, the Chinese government is well aware of this problem and is increasingly discussing solutions both concerning domestic policies and international ones,

¹⁰⁵ KROEBER, Arthur R., *China’s Economy: What Everyone Needs to Know*, New York, Oxford University Press, 2020. p.45

¹⁰⁶ GARRETT, Caroline, “Most polluted countries in the world: 2022 ranking”, Climate Consulting, January 25, 2022, <https://climate.selectra.com/en/carbon-footprint/most-polluting-countries>, (Accessed June 23, 2023)

with an increasing collaboration with both local and international institutions to reach the common goal of sustainability and safety of the planet.

In this chapter, we are going to analyse briefly the rising of industrial policy in China and the most important applications of it on the economy. Subsequently, an analysis of the green concept in China and its gradual importance on the economy is given. We will see that China has promised to reach important goals that could be particularly relevant to the world's green transition, and the government is implementing different policies to develop a greener manufacturing industry. Finally, we describe the situation between China, Europe and the US, both concerning competition, the green transition and fight against climate change.

2.1.1 FROM DENG TO HU

It was the year 1978 when Deng Xiaoping became *de facto* the leader of CCP. Situation of the Chinese economy at that time was based on the principle of a Communist central planning system, hence without any type of market competition and openness to foreign economies. After disastrous policies such as the Great Leap Forward and the Cultural Revolution which both led to famine and a stagnant economy, the country needed a restoration. During Mao Zedong's leadership, the whole country's economic output was controlled by the government, and SOEs were the only companies operating in the country as they were monitored by the State.

As China began to open up in 1977-78, the initial plan was to import several foreign new technologies in exchange of petroleum exports.¹⁰⁷ Of course, this plan was extremely optimistic since the will of the country's government to finally open to the world after a period of isolation exceeded calculation of costs and the actual availability of all these resources. In fact, the plan failed because of the impossibility to reach the amount of petroleum export promised by the government. This was not the only policy that failed, or was overestimated during that historical period. However, market-oriented reforms has changed China's economy structure for the good. The liberalisation of farm policy and the subsequent privatisation of land, the increasing privatisation also of SOEs and their fragmentation into different smaller companies, the increase of foreign trade also thanks to the law on Joint Venture adopted in 1979 are just examples of the huge changes planned by the Four Modernisations plan (modernisation of agriculture, industry, science and technology, and defence) that the Chinese economy went through during these years. Another

¹⁰⁷ NAUGHTON, Barry, *The Rise of China's Industrial Policy, 1978 To 2020*, Mexico, Academic Network of Latin America and the Caribbean on China, 2021. p.31

important move made by Deng's administration was the creation of Special Economic Zones (SEZ) firstly in Shenzhen, Zhuhai, Shantou, and Xiamen, then extended to other provinces in 1984. It is important to recognise the huge flux of foreign investment and new technologies that these SEZ brought to China. These zones are still present nowadays and they all have its own policies that boost foreign investments on different sectors such as high-tech. They are still considered as fundamental for the development of Chinese technologies, and the success of this policy led the government to export it to other economies like Africa.

This strategy was about exploiting China's comparative advantage of labour-intensive industries such as textile, toys etc., and focus on the export of these commodities. Prices were low because of an also cheap labour force and bad quality which actually ruined the Chinese reputation, priority was given to the amount of export, rather than to the quality of it.

Even if we have already mentioned the gradual privatisation of SOEs, we should not considered this phenomenon as a general one. Actually, a lot of national champions were promoted to operate on strategic sectors already mentioned. These were also well protected by FDI and consequent foreign competition.¹⁰⁸ This approach lasted for several years. In fact, in 1997 during the 15th CCP Congress, it was decided to privatise smaller SOE and reconstruct bigger ones. These 80 national champions were operating on strategic sectors, namely automobiles, electronics, energy, metallurgy, mining, machinery, chemicals, construction, transport, aerospace, and pharmaceuticals.¹⁰⁹

After a period of uncertainties and tumult, the famous visit of Deng to Southern regions revitalised the country's economy with a set of new reforms and amelioration of the previous ones.

Commodities were almost entirely market-priced by the end of the 1990s¹¹⁰ and the focus was on enhancing FDI, which was almost entirely use for export manufacturing.

Deng's successor, Jiang Zeming, extended China's opening to the rest of the world by entering the WTO in 2001. But before this, Jiang had to face an extreme rise of the inflation, caused by corruption and bankruptcy of several SOEs. Moreover, the increasing disparity between rural and urban areas caused a huge migration of people in search of a better job and thus a better life. Jiang promoted a greater collaboration between cities in order to alleviate disparities, also by abolishing some targeting policies that could damage other industries.¹¹¹ However, he continued the trend set by its predecessor Deng, that is focusing on new technologies. The "Reviving the Nation through

¹⁰⁸ DEFRAIGNE, Jean-Christophe, "China's Industrial Policy", *ECRAN Short Term Policy Brief*, vol. 81, 2014, pp. 17-32. <http://hdl.handle.net/2078.3/165719>. P.31

¹⁰⁹ DEFRAIGNE, "China's Industrial Policy...", p.14

¹¹⁰ KROEBER, *China's Economy ...*, p. 48

¹¹¹ NAUGHTON, *The Rise of China's Industrial Policy ...*, p. 45

Science and Education” policy was published in 1995, calling for investments on scientific research and education.¹¹²

Everything changed as regards industrial policies during the Hu Jintao and Wen Jiabao era, which started in 2003. There was a rising feeling that the country was too dependent on foreign investments, and the labour-intensive manufacturing that characterised the country was becoming dangerous for the growth of the economy. Thus, in 2006, a new set of policies named “Medium and Long Term Program of Science and Technology” (MLP) was implemented after years of discussion with experts from all over the country. The goal was to create a national independence on technologies and innovation. Economy should not be “market-based” but “innovation-based”, so the label “Made in China” should be substituted by the “Innovated in China” label.¹¹³ The plan had the goal of R&D to reach 2.5% of GDP and a decline on dependence on FDI of 30% by 2020. Megaprojects made the plan to become real and activate a revolution of the country’s industrial system. These project are not considered proper industrial policies, but regulations to achieve them are. In fact, the actual rise of industrial policy in China happened after 2005.¹¹⁴

Together with MLP, the theory of indigenous innovation was first mentioned and supported by Hu Jintao and his successor Xi Jinping. Chinese government’s huge investments on innovation and technology were further pushed during the financial crisis of 2008, in order to help the country to be less dependent on export, which was facing an important decline.

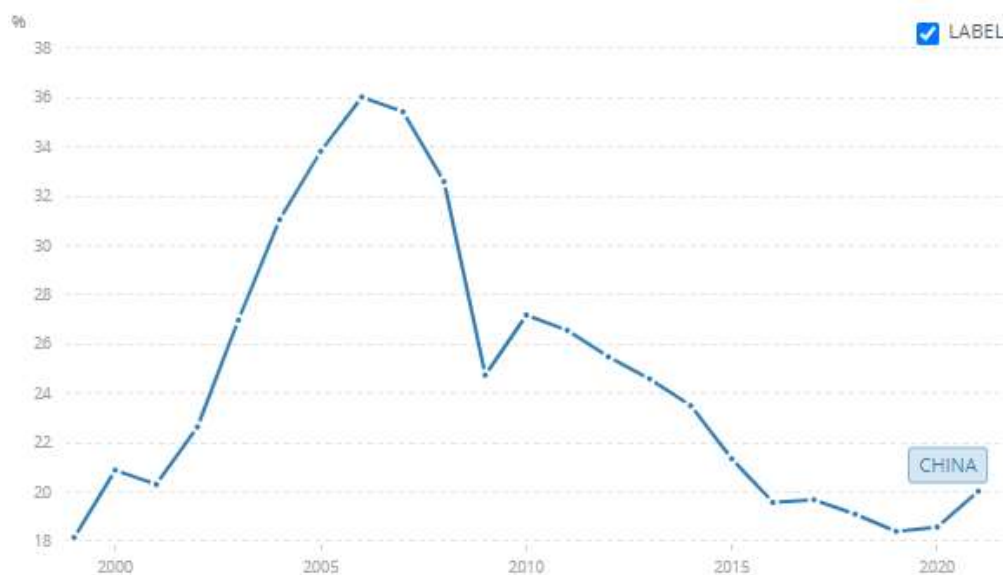


Figure 2 source: World Bank

¹¹² CHEN, Ling, NAUGHTON, Barry, *The Emergence of Chinese Techno-Industrial Policy. From Megaprojects to Strategic Emerging Industries, 2003-2011*, 2013. p.7

¹¹³ BICHLER, Joseph, SCHMIDKONZ, Christian, *The Chinese indigenous innovation system and its impact on foreign enterprises*, Munich, Munich Business School/University of Applied Sciences, 2012. p. 2

¹¹⁴ NAUGHTON, *The Rise of China’s Industrial Policy ...*, p. 47

We can deduct from this graph, which shows the percentage of China's export through the years, that the entrance of China on WTO increased its exports to 36% of the country's GDP in 2006. However, it declined drastically in 2009, following the implementation of those policies aimed to self-sufficiency just mentioned above.¹¹⁵ This trend does not imply that China is not one of the major exporter nowadays, but significant changes were made, especially in terms of FDI. Following the trend of policies aimed to the development new technologies and the abandonment of traditional industries with low-skilled labour forces, in 2010 the government recognised seven Strategic Emerging Industries (SEI) that could drive the country's development and growth. The project had 2020 as deadline, the objective was SEI to account for 15% of the country's GDP by 2020.¹¹⁶ The SEI concept is extremely important because it determined China's primate on chips and IT, but not only. Among the selected industries we are going to focus on "Energy efficient and environmental technologies" and "new energy" on a following chapter, which contain the solar industry and its related technologies.

To sum up, we can easily deduce that Hu Jintao and Wen Jiabao were the promoters of government intervention on the economy, and this method is still used by the current President Xi Jinping. Targeting policies are normal in China, as we have seen through SEZ, the Megaprojects and SEI.

2.1.2 INDUSTRIAL POLICY DURING XI JINPING

Since Xi Jinping came to power in 2012, the Chinese government has been implementing a lot of policies aimed to industrial change and economic growth. Even if at the beginning of the mandate, the President was not so focused on industrial policies, in 2015 the "Made in China 2025" (hereafter MIC 2025) program was published and a series of policies started to emerge, signalling a continuum with the precedent administration. Policies of the program are much more general-focused than those during the Hu/Wen administration, they target technologies rather than industries.¹¹⁷ Together with MIC 2025, the Internet Plus strategy was promoted. The program aims to incentivise the use of internet and other ITs in different fields, as it quite resembles Germany's

¹¹⁵ World Bank, "Exports of goods and services (% of GDP) – China", World Bank, n.d., <https://data.worldbank.org/indicator/NE.EXP.GNFS.ZS?locations=CN&start=1999>

¹¹⁶ The US-China business council, *China's Strategic Emerging Industries: Policy, Implementation, Challenges, & Recommendations*, March 2013. P.2

¹¹⁷ FISCHER, Doris, GOHLI, Hannes, HABICH-SOBIEGALLA, Sabrina, "Industrial policies under Xi Jinping: A steering theory perspective", *Issues & Studies*, vol. 57, no. 4, 2021. <https://doi.org/10.1142/S1013251121500168>. P. 2150016-18

Industry 4.0. Particularly these two strategies are extremely important for the country's economy and the topic of this essay, the green growth.

The following year, in 2016, other two important theories were risen by Xi's administration, making the importance of industrial policy even more clear. In May 2016, the "Innovation-driven Development strategy" (IDDS) and a renovation of SEIs in November were discussed and then applied to the country's economy. IDDS main goal was to foster innovation and technology and led the country to reach the top 15 in global innovation capacity.¹¹⁸ The plan established 2.5% of R&D investment to GDP, R&D investments of 2.5 trillion yuan, and an annual R&D intensity growth rate of 10.3% over 2015-2020.¹¹⁹ Innovation on the SEI Plan was made in order to meet also IDDS needs and policies, as well as coordination with those of MIC 2025 and Internet Plus. Xi Jinping and his administration catalogued nine sectors, further divided into "immediate action", namely IT industry, high-quality industrial equipment, bio and pharmaceuticals, new energy vehicles and clean energy, and digital media, and "preparatory work for later action", namely space and ocean exploration, information networks, life science and nuclear technology.

Xi Jinping is also the leader of a country that is facing several crisis, such as COVID-19 and the Russia-Ukraine war. The "zero-COVID" policy had a bad influence on foreign firms entering China. Foreign companies already established in China could not transfer its personnel from their headquarters to China. A survey by the American Chamber of Commerce in Shanghai showed that 52% of the Chamber's members parent companies lost confidence over China and one third of them have already moved their investments to other countries.¹²⁰ Decoupling has been an interesting phenomenon that is affecting the country, in particular in relation with the United States.

¹¹⁸ JUNG, Jihyun, "China's Innovation-Driven Development Strategy and Prospects", *Korea Institute for International Economic Policy*, vol. 98, 2016. p.2

¹¹⁹ Ibid.

¹²⁰ American Chamber of Commerce in Shanghai, "AmCham Shanghai Releases 2022 China Business Report", October 28, 2022, <https://www.amcham-shanghai.org/en/article/amcham-shanghai-releases-2022-china-business-report>

Characteristic	Number of established enterprises
2022	38,497
2021	47,643
2020	38,570
2019	40,888
2018	60,533
2017	35,652
2016	27,900
2015	26,575
2014	23,778
2013	22,773
2012	24,925

Figure 3 source: American Chamber of Commerce in Shanghai ¹²¹

We can clearly see the drop of the number of newly established foreign enterprises in China in 2019. This trend is of course not only linked to the “zero-COVID” policies but also to the crisis the world is facing. However, MOFCOM latest data show that EU investments in China grew in 2022, especially from Germany, despite the overall slowing of FDI during the same year.¹²²

Xi Jinping is also the President of commitment to the green growth. Recognising the country’s impact on pollution and climate change, green policies have been incremented since President Xi took power. During the opening session of the 19th Communist Party congress on 18th October 2017, the President followed Hu Jintao words and underlined the importance of the environment for China.¹²³

¹²¹ TEXTOR, C., “Number of newly established foreign invested enterprises in China 2012-2022”, Statista, 2023, <https://www.statista.com/statistics/1127022/china-number-of-newly-established-foreign-invested-enterprises/>

¹²² XIE Xiyao 谢希瑶、ZHOU Rui 周蕊、DING Le 丁乐, Wàizī cānyù zhōngguó gāo zhiliàng fāzhǎn bùfā jiākuài—tòushì 2022 nián xīshōu wàizī niánbào, 外资参与中国高质量发展步伐加快——透视 2022 年吸收外资年报 (The pace of foreign capital participating in China’s high-quality development is accelerating——Perspective on the 2022 Annual Report on Absorbing Foreign Capital), *Zhonghua renmin gongheguo zhongyang renmin zhengfu, Xinhua she*, 2023, https://www.gov.cn/xinwen/2023-01/19/content_5738101.htm, (Accessed June 1, 2023)

¹²³ HUANG, Echo, LAHIRI, Tripti, “Xi Jinping to China: ‘Any Harm We Inflict on Nature Will Eventually Return to Haunt Us’”, Quartz, 2017, <https://qz.com/1105119/watch-what-xi-jinpings-19th-chinese-communist-partycongress-work-report-said-on-climate-change/>, (Accessed June 20, 2023)

2.1.3 THE IMPORTANCE OF THE FIVE-YEAR PLANS

We have seen the general evolution of industrial policy in China from the opening-up to our present time. The question now is, how does the government fix certain goals and how these policies are presented to the public and other members?

On the previous chapter, we have seen the importance of planning when it comes to industrial policies aimed to certain industries rather than others. In fact, the government plans in advance where to allocate its resources and where to focus with policies so to make objectives much more clear. Planning is a characteristic of socialist economies, because their foundation is connected with the refuse of market-lead policies typical of capitalist countries. Speaking about China, planning has been a key tool for the country's government, even if it has changed form and priorities through the years. The first plan started in action in 1953 and it took over 1957. It resumed Soviet economic plans and the main goal was to transform the new communist China into a completely socialist country. The first Five-year Plans were purely focused on heavy-industries and on the defence industry, as we have seen before talking about the Chinese comparative advantage. Going ahead with history, the Fifth and the Sixth Five-year plans outlined the transaction to a market-oriented system, signalling also an increase of government ability on management of the country's economy.¹²⁴ Another important shift of priorities is visible on the Tenth Five-year plan (2001-2005). In fact, the Chinese government and the Planning Committee had to listen to other international organisations' suggestions, this was the deal after China entered the WTO. The entrance of the country on WTO also requested some democracy, and so different industries' and organisations' experts were called to participate on discussions over the plans. In connection to this, the Chinese name for Five-year plan (五年计划, "wunian jihua") was changed to Five-year program (五年规划, "wunian guihua") in order to make much more clear the indicative nature of it. We have actually seen the shift from a "compulsory" plan, to an "indicative" plan with the opening-up of the country and the subsequent elements of "market economy".

The Eleventh Five-year Plan (2006-2010) introduced for the first time some "binding targets" (约束性指标, "yueshuxing zhibiao"), which could be understood as promises made by the government. For the first time, energy targets were set, as the environmental awareness reached also the government level. Solar and wind energy resources were prioritised to other forms of renewables, we are going to see how reforms and investments published in the Eleventh Five-year Plan have been fundamental for the energy transition in China and the development of the solar PV industry.

¹²⁴ CHEN, Donghua, LI, Oliver Zhen, XIN, Fu, "Five-year plans, China finance and their consequences", *China Journal of Accounting Research*, vol. 10, no. 3, 2017, pp. 189-230. <https://doi.org/10.1016/j.cjar.2017.06.001>. P.196

The Twelfth Five-year Plan (2011-2015) has also been extremely important for China's development. Investments were moving to consumptions, rather than manufacturing and exports. Moreover, green transaction was still particularly relevant, and the implementation of green policies was fundamental as the country was trying to meet the Paris Agreement's goals. This concept continued with the Thirteenth Plan (2016-2020).

It is important to keep an eye on the Fourteenth Five-year program (2021-2025) which will lead China for the next two years. This is the second plan under Xi Jinping's government and it seems to be following the same concepts. The idea of *dual circulation* is here introduced and marks a huge part of the plan. In fact, we observe a tendency towards a "self-sufficient" China rather than growth based on foreign investments and foreign trade. We said before that this strategy was introduced by Hu/Wen, but Xi seems to be particularly attached to this concept. It is important to underline when the Fourteenth Five-year program entered into force. 2021 was the year of reopening for the majority of Western countries after two years of lockdown policies. The COVID-19 pandemic was still a global emergency but the economy was starting to move again. China was still isolated, but the recovery from the previous two years needed to be reached. Despite the collapse of the Chinese economy in 2020, it recovered faster than Western countries, with 2.3% growth in 2020. However, this recovery amplified imbalances through regions in China.¹²⁵

2.1.4 STRATEGIC EMERGING INDUSTRIES

The Thirteenth Five-year Plan (2016-2020) delineated a set of policies aimed to a specific support to several industries that could rise China's economy to one of the most vigorous one, together with the MIC 2025 project. In fact, it is noticeable that most of these correspond to MIC 2025 industries, signalling the complementarity of the two set of policies. New strategic emerging industries that received support are energy-saving environmental protection, next generation IT, biotechnology, advanced manufacturing, new materials, new energy vehicles, digital creative industries and high-tech services.¹²⁶ The approach of the government to these industries changed, from catching-up to a possibility to surpass other countries in the production and innovation of these products and services, with more realistic targets to be met.

¹²⁵ AGLIETTA, Michel, BAI, Guo, MACAIRE, Camille, "The 14th Five-year Plan in the New Era of China's Reform", *Policy Brief CEPII*, no. 36, 2021. p.4

¹²⁶ KENDERDINE, Tristan, "China's industrial policy, strategic emerging industries and space law", *Asia & the Pacific Policy Studies*, vol. 4, no. 2, 2017, pp. 325-342. <https://doi.org/10.1002/app5.177>. p.328

China reported that in 2021 new emerging industries' added value reached 15.3 trillion yuan, 13.4% of the GDP that year. We observe that the objective was 15% of the GDP, this means that the ultimate goal has not been reached, but it was really close.¹²⁷ By 2025, the percentage should reach 17%. In 2021 among A-share quoted firms, 35 were Chinese, in 2012 they were 23.¹²⁸ These data do not mean that SEIs do not have barriers. Actually, since the very development of these industries in 2010, there have been problems with intellectual properties, indigenous innovation capacity, qualified human resources and financing.¹²⁹ Hao, Zang, and Zhai (2022) also state that SEI, before the Thirteenth Five-year plan, had weak technological innovation capabilities, small industrial scale, low concentration, and they lack of upgrade.¹³⁰ These industries are reported to request an high intensity of knowledge, but present numerous potential benefits and a limited consumption of material resources, and so their development is considered important by the government, as they present a series of advantages that could also target social development.¹³¹ Even in a period where the pandemic shifted policies and investments on different industries, those under the SEI project had a prosperity index over 120 since the beginning of 2020.¹³² The Fourteenth Five-year plan underlines the support to these industries, also because they not only boost China's economy, but actually their development aims to social growth and environmental conservation. The Chinese government estimated that SEI's contribution to the country's GDP will account for more than 17%.¹³³

¹²⁷ Guowuyuan 国务院, guowuyuan guanyu yinfa "shisanwu" guojia zhanlvxing xinxing chanye fazhan guihua de tongzhi 国务院关于印发“十三五”国家战略性新兴产业发展规划的通知 (Notice of the State Council on Printing and Distributing the Development Plan for National Strategic Emerging Industries during the 13th Five-Year Plan Period), 2016, https://www.gov.cn/zhengce/content/2016-12/19/content_5150090.htm

¹²⁸ Guojia xinxi zhongxin xinxihua he chanye fazhanbu, xinxing chanyechu 国家信息中心信息化和产业发展部, 新兴产业处, zhanlv xing xinxingchanye shinian chengjiu huigu 战略性新兴产业十年成就回顾 (A review of the ten-year achievements of strategic emerging industries), 2023, <http://www.sic.gov.cn/News/459/11820.htm>

¹²⁹ PRUD'HOMME, Dan, "Forecasting threats and opportunities for foreign innovators in China's strategic emerging industries: A policy-based analysis", *Thunderbird International Business Review*, vol. 58, no. 2, 2016, pp. 103-115. <https://doi.org/10.1002/tie.21713>. p.104

¹³⁰ HAO Xiaoyan 郝晓燕, ZANG Linshan 臧麟山, ZHAI Yujia 翟羽佳, woguo zhanlvxing xinxingchanye jili zhengce yanjin guilv fenxi 我国战略性新兴产业激励政策演进规律分析 (Analysis on the evolution of laws of Incentive Policies for Strategic Emerging Industries in my country—Based on the perspective of policy structure*), *kexue guanli yanjiu*, vol. 40, no. 1, 2022. doi:10.19445/j.cnki.15-1103/g3.2022.01.010.

¹³¹ XU, Ke, GENG, Chengxuan, WEI, Xiaoshu, JIANG, Huifeng, "Financing development, financing constraint and R&D investment of strategic emerging industries in China", *Journal of Business Economics and Management*, vol. 21, no.4, 2020, pp. 1010-1034. <https://doi.org/10.3846/jbem.2020.12727>. p. 1015

¹³² ZHANG Zhenyi 张振翼, WU Yufan 武珣璠, 【zhuanjia guandian】 “shisiwu” kaiju zhanlvxing xinxingchanye fazhan dongneng chixu zengqiang 【专家观点】 “十四五”开局战略性新兴产业发展动能持续增强 (Expert Opinion] The development momentum of strategic emerging industries at the beginning of the "14th Five-Year Plan" continues to increase), *Guojia xinxi zhongxin*, 2021, https://www.ndrc.gov.cn/xxgk/jd/wsdwhfz/202108/t20210820_1294145.html

¹³³ The People's Government of Fujian Province, "Outline of the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and Vision 2035 of the People's Republic of China", The People's Government of Fujian Province, 2021, https://www.fujian.gov.cn/english/news/202108/t20210809_5665713.htm#C9. (Accessed July 1, 2023)

2.1.5 MADE IN CHINA 2025

The Made in China 2025 (中国制造 2025, MIC 2025) planning project was issued by President Xi Jinping and previous Premier Li Keqiang in 2015. It was designed by the Ministry of Industry and IT, which sought advice from more than 100 experts of the China engineering academy. The main objective of the project was to change from the “world’s factory” to the next innovation and technology centre, where production and industries are not based on the concept of low labour costs anymore. This is an important shift for China, as it abandons its comparative advantage of labour-intensive sectors, to capital-intensive industries.¹³⁴ The initiative is connected to the goal of the Chinese dream, a phrase connected also to the Belt and Road initiative (BRI) and the rise of China as a more and more important landmark for the world. MIC 2025 provides several policies and subsidies to help Chinese manufacturers to become more competitive and efficient. This goal is to be reached following three steps (*san bu zou* 三步走): the first one is to lead China to become a manufacturing giant by 2025. Then by 2035, China should reach the medium level of the world manufacturing powers. The third and final step is the consolidation of China as the most powerful manufacturing power by 2049.¹³⁵ The plan aims to specific sectors where these renovations should be focused:

1. Improving manufacturing innovation;
2. Deep integration of information technology and industrialisation;
3. Strengthening the foundations of the manufacturing industry;
4. Fostering Chinese brands;
5. Enforcing green manufacturing;
6. Promoting breakthroughs in key sectors;
7. Restructuring the manufacturing industry;
8. Promoting service-oriented manufacturing and manufacturing-related service industries;
9. Internationalising manufacturing.¹³⁶

¹³⁴ LIU, Xia (Summer), MEGGINSON, William L., XIA, Junjie, “Industrial policy and asset prices: Evidence from the Made in China 2025 policy” *Journal of Banking & Finance*, vol. 142, 2022.
<https://doi.org/10.1016/j.jbankfin.2022.106554>. P.1

¹³⁵ MA Huimin, WU Xiang, YAN Li, HUANG Han, WU Han, XIONG Jie, ZHANG Jinlong, “Strategic plan of ' Made in China 2025 ' and its implementation” In: *Analyzing the impacts of industry 4.0 in modern business environments*. edited by Richard Brunet-Thornton and Felipe Martinez, Hershey, IGI Global, 2018, pp. 1-23. p.3

¹³⁶ LIU, Kerry, “Chinese manufacturing in the shadow of the China–US trade war”, *Economic Affairs*, vol. 38, no. 3, 2018, pp. 307-324. <https://doi.org/10.1111/ecaf.12308>.

Ten areas were recognised as related to these important technologies: IT, robotics, aerospace equipment, ocean engineering, new materials, railway equipment, medicine, agriculture machinery and green energy and vehicles.¹³⁷

Improvement of financial support policies, reinforcement of tax and financial support, build a talent training system, and support of SMEs are only a few instruments the government is adopting in order to reach the goals mentioned above.¹³⁸ We note here a great support for innovation, with a rise of share of R&D spending of operating revenue from 1.26% in 2020, to 1.68% in 2025. Another interesting data is the invention patents per 100million RMB total revenue going from 0.36 in 2013 to 1.1 in 2025.¹³⁹ Another policy of support is the reduction of taxes from 25% to 15% for high-tech enterprises,¹⁴⁰ helping these firms to become more competitive.

The project of course rose many criticism, especially among WTO members. The US are worried about market distortions the plan could make and the menace it could cause to their national security, accusing China to violate American intellectual proprieties.¹⁴¹ This is one of the main drivers of the trade war between China and the US, and the justification of duties imposed by both countries. In fact, some Western firms are being forced to move out the country after a long period of policies favouring them in China. The main objective of the MIC 2025 project is surely to make China less dependent on foreign technologies, promoting huge investments on domestic companies.

¹³⁷ WEN, Huwei, ZHAO, Zhao, "How does China's industrial policy affect firms' R&D investment? Evidence from 'Made in China 2025'", *Applied Economics*, vol. 53, no. 55, 2021, pp. 6333-6347.

<https://doi.org/10.1080/00036846.2020.1717429>. p. 6335

¹³⁸ MA et al., "Strategic plan of Made in China 2025", p.4

¹³⁹ European Union Chamber of Commerce in China, *China Manufacturing 2025, putting industrial policy ahead of market forces*, March 7, 2017,

https://www.cscce.it/upload/doc/china_manufacturing_2025_putting_industrial_policy_ahead_of_market_force%5Benglish-version%5D.pdf. p.10

¹⁴⁰ AGARWALA, Nitin, CHAUDHARY, Rana Divyank, "'Made in China 2025': Poised for Success?", *India quarterly*, vol. 77, no. 3, 2021, pp. 424-461. <https://doi.org/10.1177/09749284211027250>. P.429.

¹⁴¹ SHEN Wei 沈伟, WTO kuàngjià xià de chǎnyè zhèngcè: Guīzé yuēshù hé zhèngcè yōuhuà ——jīyú duì "301 bàogào" jí "zhōngguó zhìzào 2025" de fēnxī, WTO 框架下的产业政策: 规则约束和政策优化——基于对“301 报告”及《中国制造 2025》的分析 (Industrial Policy under the WTO Framework: Rule Constraint and Policy Optimization ——Based on the analysis of "301 Report" and "Made in China 2025"), *Shanghai dui waijingmaodaxue xuebao*, vol. 26, no. 4, 2019, pp. 47-65. doi:10.16060/j.cnki.issn2095-8072.2019.04.005.

2.2 GREEN ECONOMY IN CHINA

The rapid and uncontrollable growth of China has made the country one of the most polluting one. Too much investments and a massive production on heavy industries, immense overgrowth of urban areas and the subsequent high request of consumers goods and energy, led the Chinese sky to turn as grey as we see on photos. According to the World Health Organisation (WHO), air pollution is responsible for about 2 million deaths in China per year.¹⁴² The Chinese government is well aware of this phenomenon, and has been working on special policies since the opening-up reform. In fact, China was on top five most polluted countries until recently, when it went down to position n.9, also due to the fact that air pollution levels dropped during the pandemic, but now they are rising again.

Pollution and climate change affect all countries of the world. Therefore, it is extremely important to support the green transition not only for merely economic reasons, but also for the better living of our future generations, whether from our country or not. We have already mentioned green economy goals, but it is important to analyse them in the Chinese context.

Needless to say, excess manufacturing is not the only reason China became the second most pollutant country in the world. Geographical size and regional disparity also played an important role. The more industrialised a city is, the more its levels of pollution are. In addition to this, we recognise a relationship between SEZ and pollution, as these zones are economic clusters with high levels of productivity, and the majority of them are collocated in coastal areas. Another challenge that the country is facing is the inevitable rising of total energy consumption, this is given to the fact that per capita consumption is still lower than other OECD countries.¹⁴³

Given these justifications, the Chinese government has been participating on the fight against climate change for several years and different industrial policies and integrations to those that already exist have been made. However, Western countries and media heavily criticized the inadequacy of these actions and call for a better collaboration with international organisations. Also

¹⁴² World Health Organization: WHO, “Air pollution in China”, WHO, 2019, <https://www.who.int/china/health-topics/air-pollution#:~:text=Air%20pollution%20is%20responsible%20for,the%20same%20period%20in%20China>, (Accessed July 10, 2023)

¹⁴³ FISCHER, Doris, “Green industrial policies in China–The example of solar energy”, in *Green industrial policy in emerging countries*, edited by A. Pegels, Routledge, 2014, pp. 69-103. P.73

Chinese citizens are not content with the government responses on pollution, they are worried about them prioritising economic profit over their health.¹⁴⁴

We are going to analyse briefly how the concept entered the Chinese economy and how it has been integrated into other industrial policies. China has certainly gained some results, these policies were not useless and their effects are benefitting the whole world. But is their effect going to last?

2.2.1 THE GREEN CONCEPT IN CHINA

China is committed to green growth and a change of the environment for the better. The Chinese government knows that its transition to a green economy is essential for the whole world's fight on climate change. However, Fischer (2014) states that China has never had "green industrial policies" that match the definition provided above, but changes over old policies to favour green development and the identification of the need to intervene on environmental protection and climate mitigation are present.¹⁴⁵ We are going to see that this is not true, as other researchers such as Allan et al. (2021) have shown.¹⁴⁶

The awareness over the impact of industrialisation on the environment has always been present among Chinese policy-makers. In fact, since the opening-up reforms in the 1970s, efforts to protect the earth were made. In 1972, the United Nations Conference on the Human Environment was held in Stockholm and China was present, signalling to the world its interest on the topic. One year later, Beijing hosted the first National Environment Conference, where it became evident the connection between safeguard of the environment and economic growth.¹⁴⁷ Following this new prospective, in 1974 the Leading Team for Environmental Protection was created under the State Council. Its main tasks were to develop guidelines, policies, and regulations to protect the environment.¹⁴⁸ The subsequent opening-up policy and the establishment of different SEZ rose the need for a special law aimed to the protection of the environment, therefore the Environmental Protection Law was issued and implemented in 1979 at the 11th Meeting of the Standing Committee of the 5th National People's Congress. This law has been continuously amended until the present day. This was a great

¹⁴⁴ "Environmental Protests Expose Weakness In China's Leadership", Forbes, 2015, <https://www.forbes.com/sites/forbesasia/2015/06/22/environmental-protests-expose-weakness-in-chinas-leadership/>, (Accessed June 10, 2023)

¹⁴⁵ FISCHER, "Green industrial policies in China". p.69

¹⁴⁶ ALLAN, Bentley, LEWIS, Joanna I., OATLEY, Thomas, "Green industrial policy and the global transformation of climate politics", *Global environmental politics*, vol. 21, no. 4, 2021, pp. 1-19. https://doi.org/10.1162/glep_a_00640.

¹⁴⁷ WENG, Xiaohue, DONG, Zhanfeng, WU, Qiong, QIN, Ying, "China's path to a green economy. Decoding China's green economy concepts and policies", *International Institute for Environment and Development*, London, 2015. P.7.

¹⁴⁸ Ministry of Ecology and Environment, "History", Ministry of Ecology and Environment, n.d., https://english.mee.gov.cn/About_MEE/History/

step for China, however, the attention was merely focused on “end-to-pipe” pollution control, which means to control contaminated flows of air just before it enters the environment. Other specific laws were implemented in these years, signalling the importance every single aspect of the environment has for the Chinese government. During the Second National Conference on Environmental Protection held in 1983, the Chinese politician Li Peng underlined the importance of green policies as long-term goals.

After Agenda 21 was adopted, China issued the “China’s Agenda 21–White Paper of China’s Population, Environment and Development in 21st Century” in 1994. The paper underlines the awareness over the importance of environment, stating that Agenda 21 is a guiding strategy that could coordinate development of population, economy, society, resources, and environment.¹⁴⁹ With this document, the first environmental goals were established. However, these were the years of economic prosperity for China, which means increase of production and energy consumption. In 2004, premier Wen Jiabao announced the adoption of green GDP, an economic indicator that takes into account also environmental costs. The first report was published in 2006 and it showed that 511.8 billion yuan were lost because of pollution. That is, 3% of the nation’s economy.¹⁵⁰ Green GDP subsequently failed in China, as it was impossible to reduce environmental damage. There were also internal problems such as an insufficient effort of local governments to focus more on environment than growth and the costs of collecting data in a country as huge as China.¹⁵¹ Since the beginning of Xi Jinping’s mandate, environmental protection and green growth have been the core concept of development in China. In 2015 a “Master Plan of Ecological Civilisation System Reform” was published, signalling the idea of protection of the environment, which is fundamental for a healthy economic development and both social and political advancement.¹⁵² This particular commitment to the environment of President Xi Jinping is being called “Green leap forward” by different media. Almost all projects promoted during Xi Jinping presidency have been adjusted with green amendments and laws, such as “The Belt and Road Initiative International Green Development Coalition” launched in 2019 to integrate sustainability into the BRI. A year after, Xi Jinping announced its intention for China to achieve carbon-neutrality by 2060. This goal can have an enormous impact on Chinese society, because of the almost inevitable change on

¹⁴⁹ Ministry of Ecology and Environment, “Report on 'Chinas' Agenda 21”, 1994, https://english.mee.gov.cn/Events/Special_Topics/AGM_1/1994agm/meetingdoc94/201605/t20160524_345213.shtml, (Accessed July 20, 2023)

¹⁵⁰ SUN, Xiaohua, “Call for return to green accounting”, China Daily, 2007, http://www.chinadaily.com.cn/china/2007-04/19/content_853917.htm, (Accessed July 20, 2023)

¹⁵¹ RAUCH, Jason N., CHI, Ying F., “The plight of green GDP in China”, *Consilience*, no. 3, 2010, pp. 102-116. <https://www.jstor.org/stable/26167790>. P. 108

¹⁵² The State Council of the People’s Republic of China, “Full Text: Integrated Reform Plan for Promoting Ecological Progress”, Xinhua, 2015, http://english.www.gov.cn/policies/latest_releases/2015/09/22/content_281475195492066.htm, (Accessed July 20, 2023)

people consumes, and on global warming. In fact, it has been said that this achievement could lower global warming temperature by around 0.2 to 0.3°C.¹⁵³

2.2.2 THE ENVIRONMENT ON FIVE-YEAR PLANS

We have understood on the previous chapter the importance of Five-year plans for the prosperity and growth of China. This is valid also for its environmental goals and policies' planning. In fact, the country has been providing an important guidance and different tools since the Ninth Five-year plan (1996-2000), when effects of rapid growth on the environment became unstoppable. Policies such as the delineation of emission standards for air pollutants and the Energy Conservation Law were here established. The Chinese Energy Conservation Law is enacted to foster energy conservation of its society as a whole, in order to protect the environment and to assure the sustainable growth of the economy.¹⁵⁴ The law was then amended in 2007. However, the interest on solar energy, wind energy and geothermal energy was particularly expressed before, on the Sixth Five-year plan.¹⁵⁵ The Tenth Five-year plan (2001-2005) also defined some standards for emissions, finalising also a law on the promotion of cleaner production in 2003. Units and individuals were to receive commendations and rewards for a clearer production.

Nevertheless, an important shift was made with the Eleventh plan (2006-2010). A rising awareness over SO₂ (sulphur dioxide) and its damaging effects on people led the government to include the target of reducing total SO₂ emissions by 10% by the end of the plan effectiveness.¹⁵⁶ The government was finally declaring its commitment to the environment, prioritising a “cycling economy”. Laws concerning pollution control were tightened and further taxes were supposed to be imposed.¹⁵⁷ The Renewable Energy Law enacted in 2006 outlined the general conditions for renewable energy to become the main energy source for the country. It covers solar, wind, water,

¹⁵³ “China going carbon neutral before 2060 would lower warming projections by around 0.2 to 0.3 degrees C.”, Climate Action Tracker, 2020, <https://climateactiontracker.org/press/china-carbon-neutral-before-2060-would-lower-warming-projections-by-around-2-to-3-tenths-of-a-degree/>, (Accessed July 25, 2023)

¹⁵⁴ HU Jintao 胡锦涛, *Zhonghua renmin gongheguo zhuxi ling – Zhonghua renmin gongheguo jieyue nengyuan fa 中华人民共和国主席令- 中华人民共和国节约能源法* (Order of the President of the People’s Republic of China – Energy Conservation Law of the People’s Republic of China), *Xinhua she*, 2007, https://www.gov.cn/flfg/2007-10/28/content_788493.htm, (Accessed July 26, 2023)

¹⁵⁵ YUAN Xueliang, ZUO Jian, “Transition to low carbon energy policies in China—from the Five-Year Plan perspective”, *Energy policy*, vol. 39, no. 6, 2011, pp. 3855-3859. <https://doi.org/10.1016/j.enpol.2011.04.017>. P.3857

¹⁵⁶ CAO, Jing, GARBACCIO, Richard, HO, Mun S., “China’s 11th five-year plan and the environment: reducing SO₂ emissions”, *Review of Environmental Economics and Policy*, vol. 3, no. 2, 2009, pp.231-250. <https://doi.org/10.1093/reep/rep006>

¹⁵⁷ NAUGHTON, Barry, “The new common economic program: China’s eleventh five year plan and what it means”, *China Leadership Monitor*, no. 16, 2005, pp. 1-10. P.5

biomass, geothermal and ocean energy. Some targets were set, such as a total of 10% of renewable energy consumption in China by 2010, and increase of it to 20% by 2020.¹⁵⁸ Subsequently, in 2007 a national plan for the development of renewable energy was announced and, in 2008, the Twelfth Five-year plan for renewable energy started to set additional goals for non-fossil energy suppliers. To pursue a shift to less polluting elements, coal factories were to receive support to encourage them to use electric power instead. Moreover, electricity, natural gases and renewable energy industries received favourable fiscal policies, tax reductions and other sort of support. In 2010 then results were published and great achievements came out. Only two targets were not met: the ration of state-level nature reserves meeting national standards and the ratio of water supply sources in key cities.¹⁵⁹ However, the environmental situation in China remained critical and a continuing green policy needed to be pursued through the Twelfth Five-year plan. Targets to be met before 2015 included: 16% less energy intensity, 17% cut in carbon intensity and non-fossil fuels to increase 11% on the country's primary energy consumption, investments to reach these and other environmental goals should have accounted for 3trillion yuan.¹⁶⁰ In fact, the Twelfth Plan introduced also the concept of new emerging industries mentioned above. Among these, sectors aimed to the protection of the environment and utilisation of natural resources were subject to tax reductions and easier access to investments and loans. Since the implementation of the Twelfth Five-year plan, China reached enormous success in climate actions. In 2012, China became the largest investor in renewable energy, underlying its commitment to the cause.

¹⁵⁸ WANG Feng, YIN Haitao, LI Shoude, "China's renewable energy policy: Commitments and challenges", *Energy Policy*, vol. 38, no. 4, 2010, pp. 1872-1878. <https://doi.org/10.1016/j.enpol.2009.11.065>. P.1873

¹⁵⁹ ZHANG, Qingfeng, CROOKS, Robert, "Environmental Strategy for the 12th Five-Year Plan Period: What Can the People's Republic of China Learn from the 11th Five-Year Plan?", *ADB Briefs*, no. 8, 2011. P.2

¹⁶⁰ BOYD, Olivia, COPSEY, Tan, "What's in the Five-Year Plan?", in *China's Green Revolution: Energy, Environment and the 12th Five-Year Plan*, China Dialogue, 2011. p.13.

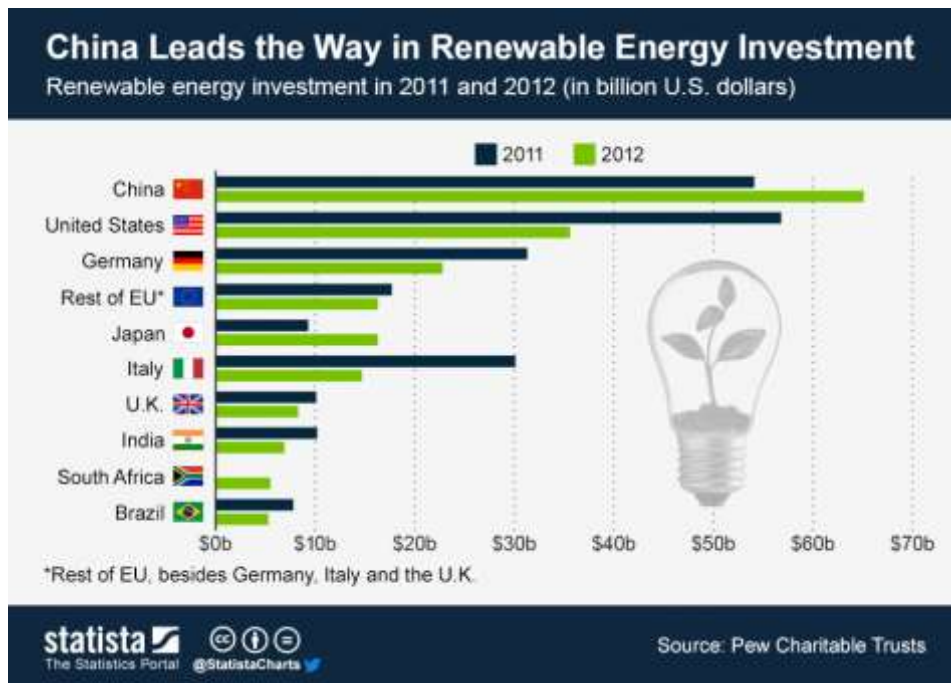


Figure 4 source: Statista¹⁶¹

A step even further was made with the Thirteenth Five-year plan (2016-2020). Energy consumption should have been lowered by 15% of GDP per unit, carbon dioxide emission by 18%. By year 2020, non-fossil fuels consumption should take 15% of primary energy consumption. A stronger collaboration to reach green solutions is called and a focus on the service industry is needed for several reasons, one of which is the lower gas emission the sector needs. China's carbon trading market was also emerging in these years, but was officially launched just in 2021. We notice an increase on detailed goals. Targets are more and more specific as green economy becomes more important every day and researches on the topic increased with the increase also of investments on it.

This path leads us to the Fourteenth Five-year plan (2021-2025) which is even more centred on the concept of environmental protection, signalling that the commitment to green development of the country was not affected by the COVID-19 pandemic, but it actually reinforced it. By 2025, China is set to reduce energy consumption to 14% per unit of GDP. Similarly, reduction of carbon dioxide emissions per unit of GDP should reach 18%. Non-fossil share should lower to 20%. For the first time, some targets were set for a longer-term prospective. The fact that Xi Jinping promised carbon neutrality by year 2060 is to be honoured, and so specific policies to reach the goal have been written.

¹⁶¹ MCCARTHY, Niall, "China Leads the Way in Renewable Energy Investment", Statista, 2013, <https://www.statista.com/chart/1340/china-leads-the-way-in-renewable-energy-investment/>

2.2.3 GREEN STRATEGIC EMERGING INDUSTRIES

We have seen that green sectors were also included in SEI programs as industries that needed more investments and where China could be more competitive.

The new plan for Strategic Emerging Industries include energy-saving environmental protection, new materials, and new energy vehicles. We consider these sectors as part of the green transaction. Energy conservation and environmental protection include energy efficiency machinery, environmental protection, and recycling and re-utilisation. Wind power, solar power, and biomass energy were part of the new energy project, while new vehicles include electric and hybrid vehicles.¹⁶² These sector were, as we previously said, categorised as a priority and so they received a bigger attention and support from the government and correlated banks. Just for a reference, new energy vehicles and new energy together were set to reach an output target of 10 trillion by 2020. In fact, the government revealed that by the end of 2021, China's energy conservation and environmental protection industry owned 49,000 invention patents classified as valid, while the new energy industry owned 60,000.¹⁶³ This data underlines the effectiveness of investments on the development of new technologies also on the green industry. Other targets to meet by 2020 were solar energy, wind energy, nuclear energy and biomass energy to take 8% of the total consumption of energy, with a production value of 1,5trillion yuan.¹⁶⁴

¹⁶² NAUGHTON, *The Rise of China's Industrial Policy...* p.61

¹⁶³ The State Council Information Office of the People's Republic of China, "Full text: China's Green Development in the New Era", Xinhua, 2023, http://english.scio.gov.cn/whitepapers/2023-01/19/content_85067818_5.htm, (Accessed July 28, 2023)

¹⁶⁴ Guowuyuan 国务院, guowuyuan guanyu yinfa "shisanwu" guojia zhanlvxing xinxing chanye fazhan guihua de tongzhi 国务院关于印发“十三五”国家战略性新兴产业发展规划的通知 (Notice of the State Council on Printing and Distributing the Development Plan for National Strategic Emerging Industries during the 13th Five-Year Plan Period), 2016, https://www.gov.cn/zhengce/content/2016-12/19/content_5150090.htm

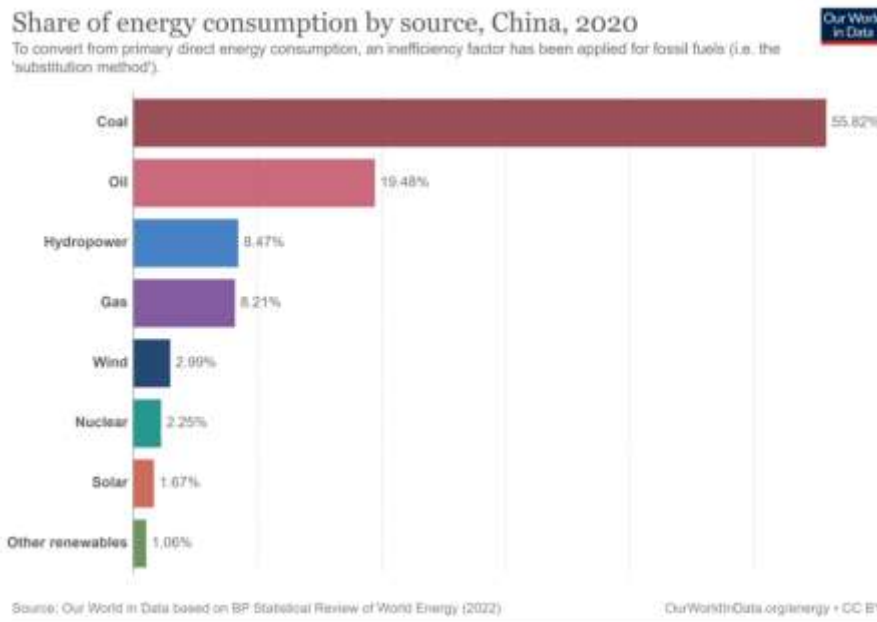


Figure 5 source: Our World in Data ¹⁶⁵

Here above we can observe the share of energy consumption by source in China by the year 2020. If we add the nuclear energy share reported as 2,25% ¹⁶⁶, we can easily calculate that the target has been reached.

As we are focusing on new energy, in particular solar energy, also on the next chapter, The US-China Business Council (2013) reports a series of policies that could help China to reach an outstanding development of these green SEI mentioned above. It mentions a higher level of research and development of new power technologies, such as nuclear power. ¹⁶⁷ The report also sees on Chinese goals an acceleration of the application of solar technologies, while also exploring on new generation methods. Wind power and a new use of biomass energy are mentioned as central renewable resources that could help energy transition in China and will benefit from policies amended for the development of SEIs. ¹⁶⁸

An important role on the development of these specific strategic sectors is played by the Ministry of Industry and Information Technology (MIIT), which is responsible for the development of specific plans for the energy efficient end environmental technologies. This ministry takes also data and publishes reports not only for national SEIs projects, but also for local ones. Local governments participate on the support, both fiscal and non, to boost these industries. We underline here a great commitment of Jiangxi government to support photovoltaics, having more than 40 enterprises

¹⁶⁵ "Share of energy consumption by source", Our World in Data, <https://ourworldindata.org/grapher/share-energy-source-sub?time=2020&country=~CHN>

¹⁶⁶ "Share of primary energy from nuclear", Our World in Data, <https://ourworldindata.org/grapher/nuclear-primary-energy?time=2020&country=~CHN>

¹⁶⁷ The US-China business council, *China's Strategic Emerging Industries...*, p.14

¹⁶⁸ Ibid.

operating in this industry. On the next chapter, we are going to analyse more deeply this particular topic and the contribution Jiangxi gave to lead China to become a leader on the global solar panel industry.

2.2.4 MIC 2025 AND THE GREEN CONCEPT

We have seen that, among the MIC 2025 goals, there is also the promotion of the shift of China from the world's factory to a country focused on innovation and technology. Innovation is also how to do the same things while saving the environment, the green production is a priority to the project in order to change the manufacturing system of the country. In fact, reduction of pollution, use of resources and environmental outputs costs reduction are goals that need to be met in order to consider MIC 2025 as a successful project.¹⁶⁹ By relying on AI, other technologies and automatism, and reducing the use of heavy industry production, changing the focus to mass consumption, the country is successfully meeting these targets. MIC 2025 promotes circular economy, reducing energy and material consumption, R&D for new green products and other technologies, better energy conservation, the creation of green data centres and green base stations and several other green goals.¹⁷⁰

As for other policies, the Chinese government set some long-term objectives. In this case, green development goals were set to be met by 2025. Besides those about the manufacturing sector amelioration and innovation, we observe the willingness to decrease energy consumption per industry unit with added value above scale to 15% from 2015 by 2020, and by 2025 a decrease of 34% from 2015. CO₂ emissions per industrial unit were also set in 2020 to run down 22% compared to 2015 and 40% in 2025. Water consumption was also included in the targets focusing on the environment. In 2020 water consumption should decrease to 23% in comparison of 2015, and to 41% by 2025. Integrated utilization rate of industrial solid waste, which accounted for 62% in 2013, should reach 73% in 2020 and 79% in 2025.¹⁷¹ On the same notice, the government promised to build 1000 green model factories and 100 model parks.

¹⁶⁹ KHONKHLONG, Suppakorn, "Made in China 2025 and its Green Production Strategic: What is the next turn of State-Owned Enterprises in China?". In: *Proceedings of the 7th Multidisciplinary in International Social Networks Conference and The 3rd International Conference on Economics, Management and Technology*, no. 20, 2020, pp. 1-4. <https://doi.org/10.1145/3429395.3429415>.

¹⁷⁰ XU, Lanxiang, "Towards green innovation by China's industrial policy: Evidence from made in China 2025", *Frontiers in Environmental Science*, vol. 10, 2022, pp. 1-10. <https://doi.org/10.3389/fenvs.2022.924250>. P.3

¹⁷¹ Guowuyuan 国务院, guowuyuan guanyu yinfa 《zhongguo zhizao 2025》 de tongzhi 国务院关于印发《中国制造 2025》的通知 (Notice of the State Council on the Issuance of "Made in China 2025), *zhonghua renmin gongheguo zhongyang renmin zhengfu*, 2015, https://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm

Among the targeted industries, new energy vehicles and new and renewable energy equipment play an important role on the reach of the environmental goal of the Chinese government. New energy vehicles industry is targeted to meet 70% of the domestic market share of Chinese products in 2020 and 80% by 2025. New and renewable energy equipment industry does not have a target set for 2020, but should directly reach 80% of domestic market share of Chinese products by 2025.¹⁷²

2.2.5 WHERE WE ARE NOW

We have seen how the green transition and the environmental protection increasingly became part of the Chinese government's interests. Policies, industrial and non, are implemented every year to guarantee a better living, a reduced impact on the environment, and a less impactful manufacturing sector. The rising awareness on the huge role that the country plays on the whole world's environment led the Chinese institutions to focus more intensively on the reduction of CO2 consumption, the increase of renewable energy consumption, and other tools aimed at the realisation of these goals. This phenomenon is also driven by political and economic motives, especially if we consider that the COVID-19 pandemic started in China and the country has been the most polluting country of the world for several years. Discussions over the topic were part of the Fourteenth Five-year Plan development, as we have seen, but are continuously discussed by different institutions. The last "Two sessions", held by the National People's Congress (NPC) and the Chinese People's political Consultative Conference (CPPCC), which took place in March 2023 showed a new focus on moderate growth, following the line of reasoning that started with the Fourteenth Five-year Plan¹⁷³, Song (2023) states. It has been observed a different language and tone compared with the previous work reports. In fact, on the 2023 report, Li Keqiang focused on the fact that the government worked hard to reach the environmental goals set, instead of underlying a great ambition.¹⁷⁴ Li Keqiang (2023) reported on its intervention at the first session that number of days with heavy pollution dropped by over 50%, energy consumption per unit of GDP fell by more than 8% and CO2 emissions dropped by 14% in the last year.¹⁷⁵ Moreover, the share of clean

¹⁷² BACKGROUND, *Made in China 2025*, Institute for Security & Development Policy, 2018, <https://isdpc.eu/content/uploads/2018/06/Made-in-China-Background.pdf>, p.4

¹⁷³ SONG Ziyang, "China's two sessions of 2023: trend for green development, green finance, and Belt and Road Initiative (BRI)", Green Finance & Development Center, 2023, <https://greenfdc.org/chinas-two-sessions-of-2023-trend-for-green-development-green-finance-and-belt-and-road-initiative-bri/>, (Accessed July 30, 2023)

¹⁷⁴ Ibid.

¹⁷⁵ LI Keqiang, "Full Text: Report on the Work of the Government", Xinhua, 2023, https://english.www.gov.cn/news/topnews/202303/15/content_WS64110ba2c6d0f528699db479.html, (Accessed June 25, 2023)

energy in total energy consumption increased from 21% to 25%.¹⁷⁶ In addition to these promising data, the Ministry of Ecology and Environment promised the construction of natural gas pipelines and other infrastructures to help a clearer heating in the country.¹⁷⁷

A recent report of Moon (2023) on the newspaper *Semafor* testifies the effectiveness of the fight against air pollution in China. Although still above the WHO's limits set, China's levels of PM2.5 have been falling since 2013.¹⁷⁸ Moreover, WHO observed that in 2021, for the first time, Beijing met its air pollution targets.¹⁷⁹ The fact is that China still counts on coal as the main source of energy, even if the range is declining slowly, and coal is the biggest air polluter. The country has still a lot to do in terms of environment, but these recent data and ambitions are particularly promising.

As we are going to analyse below, climate change cannot be fought singularly. A collaboration among all countries is needed to reach this common goal that is the environmental development. However, in this sense, there is still a conflict of priorities when it comes to green growth.

¹⁷⁶ Ibid.

¹⁷⁷ CGTN, "China to double down on efforts in fight against pollution in 2023", CGTN, 2023, <https://news.cgtn.com/news/2023-02-19/China-to-double-down-on-efforts-in-fight-against-pollution-in-2023-1hxUV9wC1t6/index.html>, (Accessed June 25, 2023)

¹⁷⁸ MOON, Jenna, "Three charts that show China's 'war on pollution' is working", *Semafor*, 2023, <https://www.semafor.com/article/05/02/2023/china-pollution-in-three-charts>, (Accessed June 23, 2023)

¹⁷⁹ STANWAY, David, "Beijing meets state air quality standards for first time in 2021", *Reuters*, 2022, <https://www.reuters.com/business/environment/beijing-meets-state-air-quality-standards-first-time-2021-2022-01-04/>, (Accessed June 23, 2023)

2.3 CHINA VS THE WORLD

On the previous chapter we analysed and reached the conclusion that industrial policy and competition are strongly interconnected, also when it comes to green industrial policy. China has been growing really fast and its escalation provoked, and still provokes, different responses. This topic presents different shades, as we consider political, economic, and also social reasons behind both extremely averse and highly positive reactions.

To generalise, countries with a socialist/communist party on the lead tend to be in favour of a great contribution of China to the world's economy, and not only. On the other hand, countries that define themselves as democracy pioneers are generally extremely intolerant when it comes to China. In this following part of the thesis we are going to analyse reactions from three important countries for China's economic rise. In fact, the US, and Germany and Italy as part of the European Union were and still are huge partners to China, especially when we consider economic factors. However, political tensions have been coming to surface in recent years, also following the COVID-19 and the Russia-Ukraine war where different perspectives created frictions.

As we are focusing on economy and not on politics, we recognise a general dependence on China following the oldest policies aimed to export goods and services with the comparative advantage of low-cost manufacturing mentioned before. Despite the political tensions between China and the United States, their trade rate reached a new record in 2022, with an increase from \$2.4 billion to \$153.8 billion of export to China and an increase of import from China by \$31.8 billion to \$536.8 billion.¹⁸⁰ Same story when talking about China-Germany economic relationship. In fact, Chinese export to Germany accounts for almost 12% of Germany's total trade, while German export to China accounts for just 8%.¹⁸¹ Italy has recently registered a boom on exports to China, counting for \$3.3 billion, with an unexpected rise for the pharmaceutical industry.¹⁸²

Nevertheless, these trade data led Western countries to face the rising problem of competition. In order to restrain this phenomenon among local and Chinese firms, different countries adopted different measures, also with the use of trade policy.

¹⁸⁰ LIU, Juliana, "US-China trade defies talk of decoupling to hit record high in 2022", CNN Business, 2023, <https://edition.cnn.com/2023/02/08/economy/us-china-trade-record-hnk-intl/index.html>, (Accessed June 27, 2023)

¹⁸¹ MORLET-LAVIDALIE, Anthony, "Chinese-German trade: increasing dependence", BNP PARIBAS, 2023, <https://economic-research.bnpparibas.com/html/en-US/Chinese-German-trade-increasing-dependence-1/12/2023.48097>, (Accessed June 27, 2023)

¹⁸² SALZANO Giovanni, LEPIDO, Daniele, "Italy's exports to China are booming and it's not clear why", AJOT, 2023, <https://www.ajot.com/news/article/italyas-exports-to-china-are-booming-and-itas-not-clear-why>, (Accessed June 27, 2023)

On this part of the second chapter we are going to see how China entered foreign markets and how its presence influenced its relations with both the European Union and the United States. This rising competition between the three most influential institutions of the world is visible also when it comes to green collaborations. As we have mentioned before, green development is important for all these countries, and they are trying to materialise the concept also in the manufacturing sector. In fact, Western countries are fostering a better production through the Industry 4.0 process, which shares some similarities with MIC 2025.

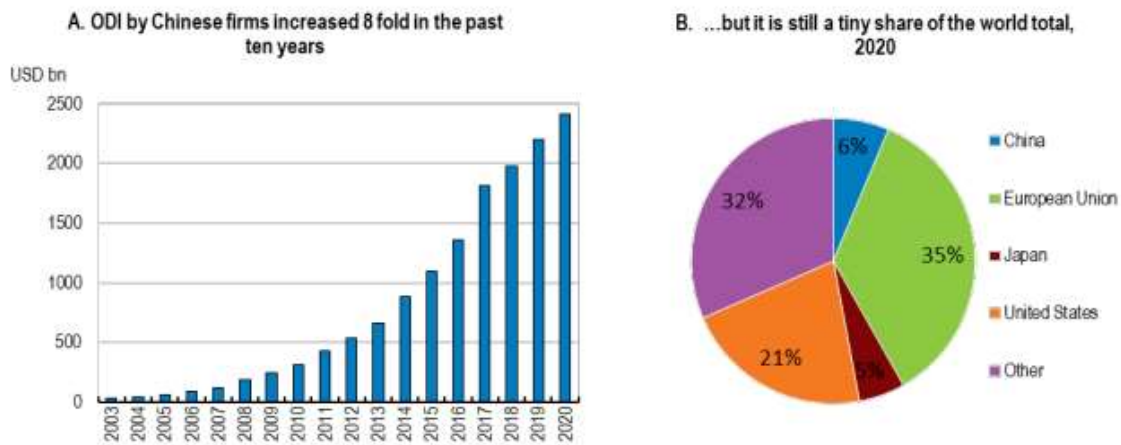
2.3.1 CHINA RISE ON THE WORLD'S COMPETITION

China started to enter competition with the world's economies just after the Open Door policy promoted by Deng Xiaoping from year 1978. As we said before, competition was not a familiar concept in China, since at the beginning of the economic reform the great majority of firms on the market were SOEs and had no competitors. With the rising FDI and relations with foreign countries, the Chinese government implemented a Competition Law only in 2008, following its entrance on the WTO. Subsequently, the fragmentation and privatisation of SOEs and an opening to the world led the country to have an internal competitive market, which is necessary to the foundation of the concept.

China has also started to increasingly invest on foreign countries. Just to give an example, China's outward investment was \$40.5 billion in the first quarter of 2023, with an increase of 18% in comparison to the year 2022.¹⁸³ However, in 2020 OECD reported that China ODI is still taking a small part of the total world investments.¹⁸⁴

¹⁸³ CHOW, Loletta, "Overview of China outbound investment Q1 2023", EY, 2023, https://www.ey.com/en_cn/china-overseas-investment-network/overview-of-china-outbound-investment-of-q1-2023, (Accessed June 29, 2023)

¹⁸⁴ MOLNAR, Margit, YAN, Ting, LI, Yusha, "China's Outward Direct Investment and its Impact on the Domestic Economy", *OECD Economics Department Working Papers*, no. 1685, Paris, OECD Publishing, 2021. P.9



Note: Total overseas direct investment stock.

Figure 6 source: CEIC and OECD Globalisation database, <http://dx.doi.org/10.1787/88893270742> ¹⁸⁵

This rising outbound investment from China inflamed different reactions, as we said before. Generally speaking, developed countries exacerbate regulations and discriminations against investment flows from China, while developing countries like those from Latin America and Africa are much more willing to receive support and investments from China. These continents are extremely strategic because of their abundant natural and agricultural resources, and so China allocated more and more investments and increased its economic presence on these countries. Secondly, the enormous presence of China in foreign countries is caused by the import dependence these countries have. We have discussed through the previous paragraphs that China's comparative advantage was the huge availability of low-cost labour resources and low-cost manufacturing. As consumerism was rising together with globalisation, a higher need for different products and services was subsequently requesting a faster production. At the beginning of its economic rise, China adopted a so-called "export-oriented" economy. In 2023, even after different policies and regulations aimed to a higher self-dependency, China had a positive trade balance of 90.2 billion dollars.¹⁸⁶ It was reported by OEC that telephones, computers, integrated circuits, cars and semiconductor devices were the most exported products, signalling the success of policies in favour of R&D and investments in new technologies.¹⁸⁷ China's biggest export partners in 2022 were the United States, Hong Kong, and Japan. Germany was the 8th, while Italy just the 19th after Brazil.

These, we can deduce, are the two main reasons why and how Chinese firms entered foreign competition. But we can also add an interesting topic, which is a rapid internationalisation of Chinese firms. In fact, thanks to policies facilitating these outbound acquisitions, M&A volumes are

¹⁸⁵ Ibid.

¹⁸⁶ OEC, "China", OEC, 2023, <https://oec.world/en/profile/country/chn>, (Accessed June 29, 2023)

¹⁸⁷ Ibid.

growing faster than expected and this tendency is rising concerns around the world. We are going to discover if this rising competition is present also when talking about those industries that are considered fundamental for the green transition. We agree that the fight to climate change and the amelioration of the environment are something that cannot be done individually. Of course, every country should give its contribution, but common goals should be set and discussions over collaboration are fundamental, we are all in this together.

2.3.2 RELATIONS WITH THE EUROPEAN UNION

China has always viewed the EU as an important and strategic economic partner. Diplomatic relations started in 1975, when the EU was made of nine member countries and China was starting to open up to the foreign world. Since then, trade and other relations rose enormously, creating also a dependence from both sides, especially after China's entrance in the WTO. Even if political relations have always been difficult and turbulent, they both continue to cherish this cooperation. In 2019 a Memorandum of Understanding was signed, signalling a mutual exchange of views over competition. Similarly, the Terms of Reference were signed in 2004 and renewed in 2019 established a forum where Chinese and European institutions could consult each other over competition policies and legislations. These documents are extremely important if we consider the reciprocity these institutions have, especially when it comes to economics.

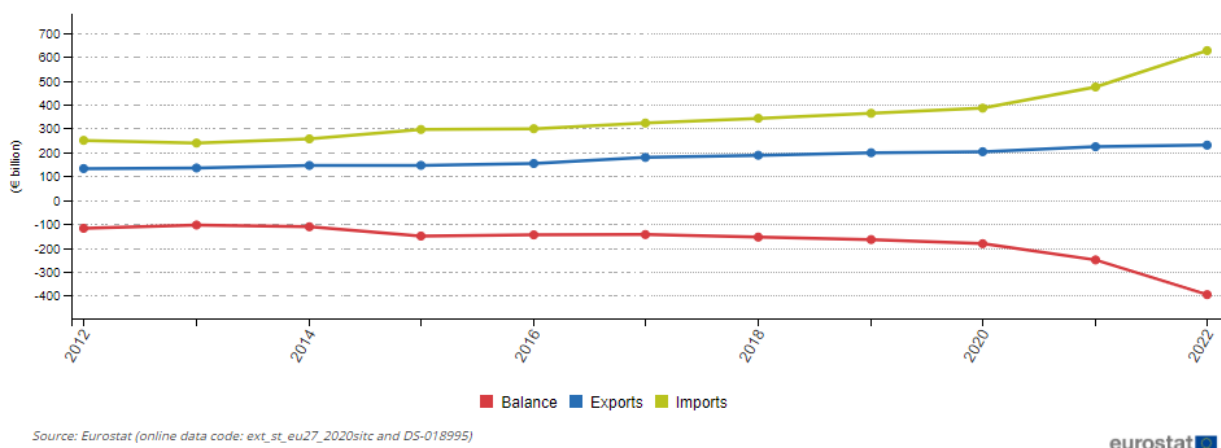


Figure 7 source: Eurostat¹⁸⁸

¹⁸⁸ Eurostat, “China-EU - international trade in goods statistics”, Eurostat, 2023, [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=China-EU - international trade in goods statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=China-EU_-_international_trade_in_goods_statistics), (Accessed July 01, 2023)

We can deduct from this graph that the EU is extremely reliant on Chinese exports, especially in the last few years when trade deficit has been increasing fast. However, the EU member states are worried about a lack of transparency by Chinese institutions, industrial policies favouring national firms, government intervention on the economy and poor protection of intellectual property rights, and so the tendency is to focus on answering the question of independence.¹⁸⁹ For these reasons, in 2020 negotiations on the Comprehensive Agreement on Investment (CAI) began to take place. The EU is asking for a fairer entrance of European investors in China also in industries where foreign investments are banned or limited. European members are asking for an increase of transparency and less government intervention on foreign firms. An important fact about this agreement is that it is based on the principle of sustainability. Surprisingly, both partners have rectified several Multilateral Environmental Agreements (MEA) to improve environmental protection standards, as sustainability is an important pillar for both institutions. The People's Bank of China is also one of the members of the EU-led International Platform on Sustainable Finance, which mobilises policymakers to discuss measures about developing sustainable finance.

The fact is that China-EU relations over climate change and sustainability have a dual face. Apart from some formal deals and dialogues, China and the EU do compete to get the leadership position in green sectors and technologies. As the Chinese government promised to the world that the country will reach carbon neutrality by 2060, its total spending on R&D and innovation is estimated to reach \$15 trillion, an amount that the EU is not spending nowadays.¹⁹⁰ The EU is extremely worried about Chinese companies that are catching up and taking the lead over industries where European countries used to top the market. For instance, if we check the Global Top 15 Wind Turbine Manufacturers in 2022, we notice that China is leading in quantity, with Goldwind (4), Envision Energy (5), Minyang (6), Windey (8), SEWind (10), DEC (11), CSIC (12), CRRC (13), and SANY Renewable Energy (15).¹⁹¹ Other positions are almost all taken by European countries. In order to face this rising dependence and competition with Chinese manufacturers, the European Commission imposes anti-dumping and anti-subsidy duties on different Chinese products, one of which used to be solar panels, this particular industry is to be analysed on the next chapter. Moreover, since China is one of the major economic partners of the EU, it is greatly affected by the Carbon Border Tax imposed by the European Union after the Carbon Border Adjustment

¹⁸⁹ European Commission, "China", European Commission, https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/china_en

¹⁹⁰ OERTEL, Janka, TOLLMANN, Jennifer, TSANG, Byford, "Climate superpowers: How the EU and China can compete and cooperate for a green future", European Council of Foreign Relations, 2020, <https://ecfr.eu/publication/climate-superpowers-how-the-eu-and-china-can-compete-and-cooperate-for-a-green-future/>, (Accessed July 03, 2023)

¹⁹¹ "Global Top 15 Wind Turbine Manufacturers", Blackridge, 2022, <https://www.blackridgeresearch.com/blog/top-wind-turbine-manufacturers-makers-companies-suppliers>, (Accessed July 3, 2023)

Mechanism (CBAM) legislation. In fact, the EU is imposing this tax to non-EU countries' exports in order to incentivise climate ambitions and ensure EU climate effort.¹⁹² The first phase of this legislation is still on work, so we still do not know the real impact of it. Yet, in the long-term point of view, it will impact these Chinese industries, also if we think about the possibility of a worsening of these sanctions.

However, as the green concept is important for both entities, dialogues over the climate change crisis and environment have continuously taken place. On July 2023, European Commission Executive Vice-President Frans Timmermans and First Vice Premier of PRC Ding Xuexiang held a dialogue in Beijing, the fourth China-EU High Level Dialogue on Environment and Climate (HECD), where the necessity of collaboration over this topic should not be questioned. During the dialogue, both European and Chinese green policy frameworks have been presented, confirming also the commitment to COP28 goals.¹⁹³

As one of the most relevant country of the European Union in terms of green development, Germany has long contributing with China to fight together the problem of climate change. In June 2023, the two countries signed a Memorandum of Understanding stating that they are carrying a collaboration on industrial decarbonisation, energy transition to renewable energies and other fields.¹⁹⁴

2.3.3 RELATIONS WITH THE US

Competition between China and the US is extremely complicated and it takes different perspectives and fields, as they are the two most powerful countries of the world. The relations between the two are extremely complex, we observe moments of collaborations and others of tension and competition. When China joined WTO, the American institutions did not completely agree, because of the lack of transparency of Chinese firms and institutions. Moreover, China's relations with Russia have always worried the US, as they faced Cold War against Russia and they have a different political system, as China. But collaboration somehow is also needed: in year 2000 China

¹⁹² WU Yi, "How Will the EU Carbon Border Adjustment Mechanism Impact China Businesses?", China Briefing, 2023, <https://www.china-briefing.com/news/how-will-the-eu-carbon-border-adjustment-mechanism-impact-china-businesses/>, (Accessed July 03, 2023)

¹⁹³ Directorate-General for Climate Action, "Readout of the Fourth EU-China High-Level Environment and Climate Dialogue", European Commission Website, 2023, https://climate.ec.europa.eu/news-your-voice/news/readout-fourth-eu-china-high-level-environment-and-climate-dialogue-2023-07-04_en, (Accessed July 12, 2023)

¹⁹⁴ Federal Ministry for Economic Affairs and Climate Action, "Germany and China sign Memorandum of Understanding to launch climate and transformation dialogue", Federal Ministry for Economic Affairs and Climate Action, 2023, <https://www.bmwk.de/Redaktion/EN/Pressemitteilungen/2023/06/20230620-germany-and-china-sign-memorandum-of-understanding-to-launch-climate-and-transformation-dialogue.html>, (Accessed July 04, 2023)

and the US signed the United States–China Relations Act, which ensured that they both comply with human rights laws and the willing of both to not trade products that were made in labour camps or prisons.

However, the trend has always been the same. Both imports and exports between China and the US still grow every year. China is the biggest importer of American products, while the U.S. is the biggest importer of Chinese products. The anomaly is that the American deficit over trade with China is increasing steadily: in 2022, the U.S. accounted for \$154,012.1 in exports to China and \$536,307.1 imports from China, with a deficit of \$-382,295.0.¹⁹⁵ There is a constant increase of trade deficit from the US. This to underline the fact that even if the two governments are in conflict, they are still extremely dependent on each other and they are not destined to suspend their economic exchange in the short-term, maybe not even in the long-term.

The US government has adopted several measures to punish Chinese individuals and companies anti-competitive behaviour. Just to mention under the Trump administration, Huawei and ZTE products were banned for security concerns in the U.S. federal government. Huawei has also been added to the Entity List in 2019 together with its subsidiaries, and with this it was prohibited to the company to buy parts and components from US companies without having previously the government's authorisation.¹⁹⁶ Under the Trump administration it was also prohibited to American companies to invest on Chinese companies accused to be controlled by the Chinese military.¹⁹⁷ More recently, under the Biden administration, sanctions over Chinese companies were almost completely aimed to punish those firms accused to help Russia's attack against Ukraine. In 2023, 28 more Chinese companies have been added to the Entity List. They were accused of exports of security equipment to Iran and Myanmar militaries.¹⁹⁸

As the two most polluting countries of the world, they are both concerned about climate change, even if actions taken by the governments are different. Nevertheless, as we stated for EU-China relations, it is important to collaborate and find some solutions together. This collaboration is tested every year, with different accusations and sanctions. As China grew its market on renewable energy, it has been accused of unfair regulations and steal of property rights. On the other hand, Trump led the US to withdraw from the Paris Agreement, which was a delusion for every country that signed

¹⁹⁵ United States Census Bureau, "Trade in Goods with China", United States Census Bureau, <https://www.census.gov/foreign-trade/balance/c5700.html>, (Accessed July 04, 2023)

¹⁹⁶ TOMAS, Juan Pedro, "Huawei already replaced 13,000 components due to U.S. sanctions", RCR Wireless News, 2023, <https://www.rcrwireless.com/20230321/network-infrastructure/huawei-already-replaced-13000-components-us-sanctions#:~:text=In%20May%202019%2C%20the%20U.S.,buy%20components%20from%20U.S.%20suppliers.>, (Accessed July 04, 2023)

¹⁹⁷ PAMUK, Humeyra, ALPER, Alexandra, ALI, Idrees, "Trump bans U.S. investments in companies linked to Chinese military.", Reuters, 2020, <https://www.reuters.com/article/usa-china-securities-idUSKBN27T1MD>, (Accessed July 4, 2023)

¹⁹⁸ WILLEMYNS, Alex, "US blacklists 28 more Chinese firms", RFA, 2023, <https://www.rfa.org/english/news/china/bgi-entity-list-03032023135505.html>, (Accessed July 04, 2023)

the agreement. The Chinese President Xi Jinping took the opportunity to mark its intention to continue its commitment to the Agreement, promising a higher amount of investments for the fight against climate change.¹⁹⁹ Nevertheless, initiatives of collaboration did actually exist. The US-China Energy Cooperation Program (ECP) was founded in 2009 and it was supported by different government agencies from both countries. Moreover, the U.S.-China Clean Energy Research Centre (CERC) brought together researchers from China and the US to collaborate on the creation of new technologies that aimed at energy efficiency.

2.3.4 MIC 2025 VS INDUSTRY 4.0

MIC 2025 and Industry 4.0 are often compared, as they are two of the most prominent projects in terms of development and technology.

Industry 4.0 was first mentioned in Germany in 2011 and it was immediately well accepted by different institutions, especially because it could solve the problem of producing a huge amount of goods and services with little natural resources and, at the same time, meeting the high demand.²⁰⁰ Moreover, the Industry 4.0 project also aims at sustainability, as history teaches us that industrial revolutions imply economic, technological, social, and also environmental changes.²⁰¹ Particular to this industrial revolution is the introduction of artificial intelligence, gene editing, and robotics in the manufacturing world.²⁰² The integration of the Internet of things (IoT) and augmented reality increase automation and less human intervention on machines' issues. This particular integration, together with the amelioration of products' quality and innovation, is the core concept that characterise both projects.

MIC 2025 is greatly inspired by the Industry 4.0 project, as they both concern manufacturing. However, the Chinese project has a broader vision, since its goal is to restructure the entire industry. In fact, its target is to shift from the "Made in China" label to the "Designed in China" one²⁰³, as Ling Li (2018) stated, while "Industry 4.0" is more about controlling the life cycle of the

¹⁹⁹ QI, Ye, "China's perspective on the US withdrawal from the Paris Agreement", BROOKINGS, 2017, <https://www.brookings.edu/articles/chinas-perspective-on-the-us-withdrawal-from-the-paris-agreement/>, (Accessed July 5, 2023)

²⁰⁰ GHOBAKHLOO, Morteza, "Industry 4.0, digitization, and opportunities for sustainability", *Journal of Cleaner Production*, vol. 252, 2020. <https://doi.org/10.1016/j.jclepro.2019.119869>. P.2

²⁰¹ Ibid.

²⁰² PHILBECK, Thomas, DAVIS, Nicholas, "The Fourth Industrial revolution: shaping a new era." *Journal of International Affairs*, vol. 72, no. 1, 2018, pp. 17–22. <https://www.jstor.org/stable/26588335>. P.18

²⁰³ LI, Ling, "China's manufacturing locus in 2025: With a comparison of 'Made-in-China 2025' and 'Industry 4.0'", *Technological Forecasting and Social Change*, vol. 135, 2018, pp. 66-74. <https://doi.org/10.1016/j.techfore.2017.05.028>. P.68

products.²⁰⁴ Another characteristic of MIC 2025 is that it is a government-led project. It is Beijing that coordinates investments, together with local governments that apply directives on their territory. Of course, also in Germany it is the government that gives financial subsidies to local companies, but trends and management of these changes are left to the companies themselves.

Concerning green industry and sustainability, both projects do reserve some space for them. We have already seen how China is aiming to these concept by targeting defined industries and installing specific parks where green industries can build their own products and services. Industry 4.0 is a promoter of sustainability in every field it can be applied. It facilitate monitoring of energy efficiency and the reduce of carbon emissions.²⁰⁵ So even when talking about sustainability and the connection that the project has with climate change, both MIC 2025 and Industry 4.0 try to reach the common goal of reducing the impact of manufacturing to our environment.

2.3.5 FUTURE PERSPECTIVES

We have seen and notice how China changed its relations, in every field, with both the US and the European Union. China is a country which prioritise its economic relations over other types of relations, and this phenomenon has always caused different views over its future and how it can change the diplomatic world. Moreover, the continuous flow of investments and acquisitions by Chinese companies, together with cheap inputs to enter the Chinese market and distortion of competition made by SOEs and Chinese subsidies, have risen no little objections against Chinese presence on foreign countries. Anti-dumping and anti-subsidy actions against China had different effects in different industries, and this could have been one of the main drivers of a rising self-reliance of China. Just to give an example, in April 2023 the EU Commission renewed anti-dumping measures for sodium gluconate imported from China, signalling a continued will for economic independence from China. However, experts are convinced that collaboration is still needed, since China is and is destined to remain one of the largest economy of the world. A survey conducted by Van Wieringen (2022) in 2022 has showed that for most of the expert interviewed, China and the EU should continue to cooperate, especially when it comes to climate and sustainability and reducing supply chain dependences.²⁰⁶ As mentioned before, on July 2023, the

²⁰⁴ Ibid.

²⁰⁵ THIEDE, Sebastian, "Environmental Sustainability of Cyber Physical Production Systems". *Procedia CIRP.*, vol. 69, 2018, pp. 644-649. <https://doi.org/10.1016/j.procir.2017.11.124>

²⁰⁶ VAN WIERINGEN, Kjeld, *EU-China 2030 European expert consultation on future relations with China*, PE 739.240, Brussels, European Union, 2022.

fourth China-EU High Level Dialogue on Environmental and Climate (HECD) was held in Beijing. Several plans to fight climate change and protect the environment were discussed, such as the European Green Deal and the Chinese 1+N policy framework.²⁰⁷ This is a positive signal of collaboration. Even if the COVID-19 pandemic crisis and the Chinese unclear view over the Russia-Ukraine War slightly ruined China's reputation, the EU recognised its importance to the world. So no surprise German Foreign Minister Annalena Baerbock (2023) stated that Germany would not succeed in fighting the climate crisis without China²⁰⁸, even if she then described economic relations with China as highly threaten by competition.

As regards China and the US bilateral climate efforts, we have seen that collaboration is not that relevant, even if it should be, since they are both the polluters of the world and the major economies of the world.

In 2009, the Clear Energy Research Center (CERC) was established by Chinese President at that time Hu Jintao and the previous US President Barack Obama, promoting researches on clear and renewable energies. But it was not sufficient. Priorities and motivations were different, and this led to miscommunication and lack of coordination problems, even if actually some progresses were made.²⁰⁹

American diplomat who serves as Envoy for Climate John Kerry was to visit China in July 2023, and this could have opened the doors for a collaboration on climate and sustainability between the two economies. However, John Kerry stated that even if the four-day visit to Beijing was productive, a new climate agreement was not reached. Both parties agreed that this important topic should be discussed furtherly, hoping for a higher commitment and collaboration.²¹⁰

²⁰⁷ Directorate-General for Climate Action, "Readout of the Fourth EU-China High-Level Environment and Climate Dialogue", European Commission Website, 2023, https://climate.ec.europa.eu/news-your-voice/news/readout-fourth-eu-china-high-level-environment-and-climate-dialogue-2023-07-04_en, (Accessed July 12, 2023)

²⁰⁸ VON DER BURCHARD, Hans, WILKE, Peter, "Germany blasts China on human rights, but shies away from economic restrictions", Politico, 2023, <https://www.politico.eu/article/germany-scholz-strategy-blasts-china-over-human-rights-but-shies-away-from-economic-restrictions/>, (Accessed July 13, 2023)

²⁰⁹ YANG, Xiaoliang, "U.S.-CHINA Clean Energy Collaboration: lessons from the Advanced Coal Technology Consortium", *World Resources Institute*, Washington, March 2016.

²¹⁰ COLMAN, Zack, "Kerry's trip to China yields no breakthrough on climate", Politico, 2023, <https://www.politico.com/news/2023/07/19/kerrys-effort-to-secure-climate-deal-with-china-falls-short-00107022>, (Accessed August 01, 2023)

3.1 THE SOLAR PANEL INDUSTRY

A solar panel, or photovoltaic, is a tool used to convert sunlight into electrical energy. It was invented by Charles Fritts in 1883 after the French physicist Edmond Becquerel discovered the photovoltaic effect in 1839.²¹¹ As every other invention, it was developed during the years also thanks to numerous and increasingly heavy investments by the states and researches, also patents increased a lot during its development years, especially in the United States. The solar panel was first tried to be mass-produced in the 1960s and 1970s in the United States following the energy crisis that affected the country, but high costs did not help the industry to increase its market. Today, this sector is going really well thanks to the increase of demand and the efficient supply chain, and a deepening awareness over the importance of renewable energies.

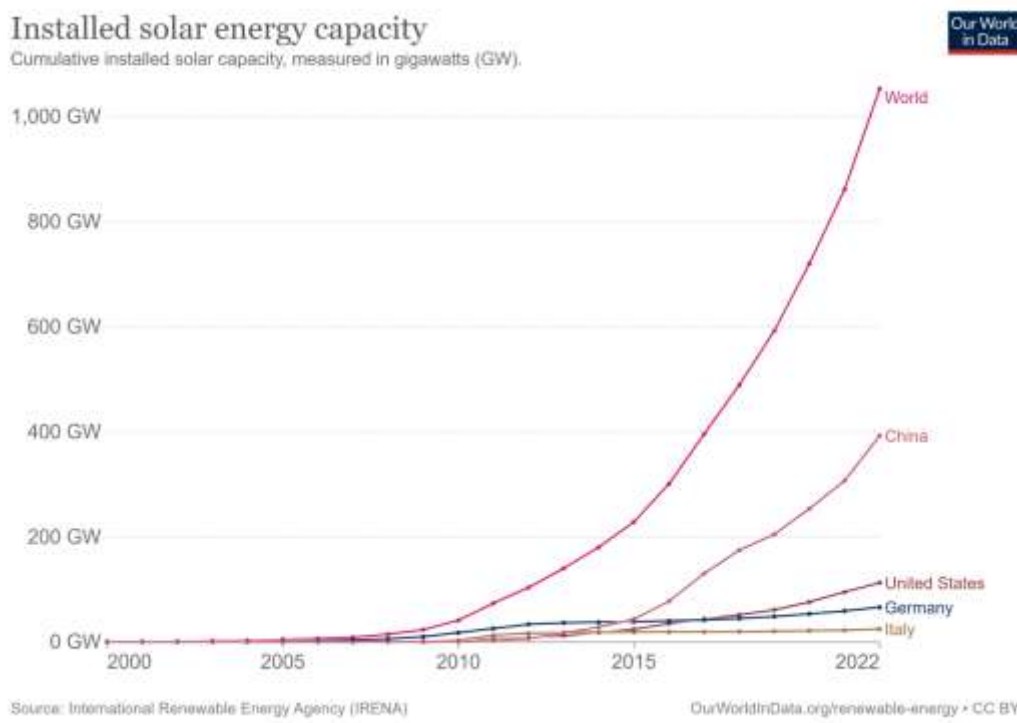


Figure 8 source: Our World in Data²¹²

In 2000, no country installed more than 1GW of solar capacity. In 2022, after years of incentives both on the micro- and the macro- side of the economy, the cumulative installed solar capacity of

²¹¹ KNIER, Gil, “How do Photovoltaics Work?”, NASA SCIENCE, 2008, <https://science.nasa.gov/science-news/science-at-nasa/2002/solarcells>, (Accessed July 17, 2023)

²¹² IRENA, “Installed solar energy capacity”, Our World in Data, <https://ourworldindata.org/grapher/installed-solar-PV-capacity>, (Accessed July 18, 2023)

the world has reached 1.053GW. It is impressive how China accelerated its installation of photovoltaic systems. We have already seen the enormous amount of policies aimed to the boost of renewable energy resources, like the solar energy. The industry of solar panels is one of the most discussed but prominent sector in China. It started as an export-oriented sector, to become an industry with an increasing internal demand, forced also by a rising concern among foreign countries as regards competition. In fact, a lot of foreign firms suffered from the cheaper supply chain created by China and several of them were forced to close and declare bankruptcy, or at least lost a huge slice of the market. For instance, Germany has been one of the greatest PV installer country, accounting for 67.3GW of total installed capacity in 2022. Italy is also an important contributor in the instalment of solar PV systems, becoming the third country in terms of installations during the 2010s. Even though it promoted several researches and development in the sector, the US are still behind China and the EU in terms of installed PV and combined solar power capacity.²¹³

To understand better the role of China in the solar systems supply chain, we should know the basic value chain of the final product. Generally speaking, it all starts with the refine of silicon dioxide (SiO₂), which is then melted and cast into blocks or ingots and then turned into wafers with an anti-reflective coating on it. Wafers can be monocrystalline or polycrystalline. Monocrystalline wafers are more efficient panels, but they cost more. Metal conductors are added on each wafers' surface to ensure the conversion of solar energy to electricity. A solar panel is then composed by several solar cells linked with other metal connectors. Subsequently, the panel is covered by glass and then the junction box is added to connect all the modules inside.²¹⁴

On this chapter, we will first focus on how the PV industry was developed in China and different policies that the government published and amended in order to boost its market. We then move to the competition the industry faced while expanding its market to foreign countries. It is interesting to see how EU members, especially important economic partners as Germany and Italy, dealt with it. Also, we are going to see how this competition influenced relations with the US. We would like to take into consideration also technologies and development of this sector, analysing different subsidies and investments made by each country in examination, but also countermeasures such as tariffs and anti-dumping measures to contrast the unequal competition. The debate is also about the dilemma that these disputes raised between give much more importance to the environmental goal of the industry or to stress the importance of free competition which does not allow monopolies and

²¹³ IRENA, *Renewable Energy Statistics 2022*, Abu Dhabi, International Renewable Energy Agency, 2022. p.32

²¹⁴ "How are Solar Panels produced?", Green Match, 2023, <https://www.greenmatch.co.uk/blog/2014/12/how-are-solar-panels-made> , (Accessed July 24, 2023)

other types of unfair treatments. This is an important topic which is still relevant today, as we are going to see at the end of this chapter dedicated to the PV sector and its competition.

3.1.1 THE SOLAR PV SECTOR IS CHINA

With the rising of China as a modern economy, the demand of energy consumption also increased. Suffice is to know that factories and other types of infrastructures were founded and also expanded during these flourishing years, and in order to work they obviously need energy. Trends were reporting that energy produced by traditional energy resources alone were about not to be sufficient to satisfy the consumption needs. Therefore, China had to accelerate the advancement of new renewable energy tools.²¹⁵

As we previously mentioned, the two most important sources of renewable energy in China are wind and solar power, as the country is one of the sunniest place of the world. In fact, over 60% of the Chinese territory accounts for more than 3000h of annual sunlight, having annual radiation surpassing 5400MJ.²¹⁶ South West and North regions have a huge solar potential, and the government has well thought to use it. Solar energy is essentially obtained through photovoltaics or the use of concentrated solar power systems, these are the main technologies that can use sun to make energy nowadays.

China recognised the value of this sector and started to invest on it from the 1960s, making it one of the country's biggest export sectors. It is important to say that photovoltaics are made of different components, where China dominates almost entirely the supply chains. Silicon materials, wafers, cells, and other components are cheaper in China because of different laws, policies and other factors, such as advanced technologies and comparative advantages, and this made foreign countries to be dependent on its exports.

Going behind history, in 1958 the first monocrystalline silicon piece was developed in China. The project was then continued by the Institute of Semiconductors of the Chinese Academy of Sciences with a failing research on batteries.²¹⁷ In 1975 the two first factories of solar batteries were inaugurated in Ningbo and Kaifeng. The government was giving more and more attention to this

²¹⁵ ZHAO, Zhen-yu, ZHANG, Shuang-Ying, HUBBARD, Bryan, YAO, Xue, "The emergence of the solar photovoltaic power industry in China", *Renewable and Sustainable Energy Reviews*, vol. 21, 2013, pp. 229-236. <https://doi.org/10.1016/j.rser.2012.12.066>, p.229.

²¹⁶ WU, Zhiyong, HOU, Anping, CHANG, Chun, HUANG, Xiang, SHI, Duoqi, WANG, Zhifeng, "Environmental impacts of large-scale CSP plants in northwestern China", *Environmental Science: Processes & Impacts*, vol. 16, no. 10, 2014, pp. 2432-2441. <https://doi.org/10.1039/c4em00235k>.

²¹⁷ Guangfu Xingxing 光伏星星, *Zhongguo guangfu fazhan shi 中国光伏发展史 (History of PV in China)*, in *nengyuanjie 能源界*, 2020, <http://www.nengyuanjie.net/article/33815.html>, (Accessed July 19, 2023)

sector, to the point that it introduced a project of policy support to the PV manufacturing industry on the Sixth Five-year Plan (1981-1986). Thanks to these subsidies and financial help from the government, the solar power sector began to grow. Power stations were installed in Inner Mongolia and Tibet between 1986 and 1989, starting also to sell products abroad as requests were getting bigger and bigger. This was just the beginning: during the first decade of the 21st century, companies like Suntech and Yingli Green Energy started to dominate the industry in China.²¹⁸

Investments in manufacturing started to emerge in these years. In 2003, the “Directory of High and New Technology Products Encouraging Foreign Investments” supported FDI on different PV components such as inverters and modules.²¹⁹

The escalation was fast. In 2022, according to China Photovoltaic Industry Association (CPIA), the export of solar PV materials and products increased more than 80% in comparison to the previous year, surpassing \$51 billion worth.²²⁰ At the beginning of the development of the sector in 2005, export were accounting for just \$22 million.²²¹ This sector was included in the Renewable Energy Law introduced by the Chinese government in 2006, and then amended in 2009. The law also included on-grid solar PV energy, even if in practice this topic did not receive huge attentions.²²² In fact, Beijing gave the priority to wind energy, authorising only 4 solar PV plants between 2007 and 2008.²²³ The law provided for grid companies had to accept all the power generated by renewable energy sources at a defined price given by the government which also introduced favourable taxes and treatments for renewable energy system projects.²²⁴ The government also encouraged installation of solar PV in private homes and factories.²²⁵ Previously to the Renewable Energy Law, China’s Ministry of Science and Technology classified investments from foreign parties on PV system parts, such modules and inverters, on the “Directory of High and New Technology Products Encouraging Foreign Investments”. In 2005 the National Development and Reform Commission (NDRC) also introduced special measures for modules, ingots and other components.²²⁶ 2006 was also a year of development in the PV industry. The NDRC also issued a “Notice on the Interim

²¹⁸ ZHAO et al., “The emergence of the solar photovoltaic”, p.232

²¹⁹ ZHI, Qiang, SUN, Hongbang, LI, Yanxi, XU, Yurui, SU, Jun, “China’s solar photovoltaic policy: An analysis based on policy instruments”, *Applied Energy*, vol. 129, 2014, pp. 308-319. <https://doi.org/10.1016/j.apenergy.2014.05.014>, p.312.

²²⁰ JOSHI, Arjun, “China’s Solar Exports Jump 80% in 2022 Despite New Trade Barriers”, MERCOM, 2023, <https://www.mercomindia.com/chinas-solar-exports-jump-80-2022>, (Accessed July 22, 2023)

²²¹ HOPKINS, Matthew, LI, Yin, “The Rise of the Chinese Solar Photovoltaic Industry: Firms, Governments, and Global Competition”, in *China as an Innovation Nation*, edited by Yu Zhou, William Lazonick, and Yifei Sun (eds), Oxford, Oxford Academic, 2016.

²²² SCHUMAN, Sara, LIN, Alvin, “China’s Renewable Energy Law and its impact on renewable power in China: Progress, challenges and recommendations for improving implementation”, *Energy Policy*, vol. 51, 2012, pp. 89-109. <https://doi.org/10.1016/j.enpol.2012.06.066>. P.105

²²³ FISCHER, *Green industrial policies in China*, p.82

²²⁴ Ibid.

²²⁵ Kezaisheng nengyuan fa 可再生能源法 (Renewable Energy Law), 2006

²²⁶ ZHI et al., “China’s solar photovoltaic policy”, p. 312

Method for Renewable Energy Generated Power Pricing and Cost Allocation Management” which confirmed subsidies for the renewable energy market.²²⁷

Even if in 2007 China was already the best on production of PV cell modules, the financial crisis of 2008 also played a role on the development of export of PV systems. While Western countries were dealing with the financial crisis, China stimulated internal demand of the sector as also external demand was decreasing due to the slowdown of installations.²²⁸ In 2009, the “Accelerating the Implementation of Solar PV Building” policy was amended to support demonstration projects, together with the “Large-scale PV Power Station Concession Bidding” and the “Golden-Sun Pilot Project” promoted by other departments.²²⁹ This last project has been the most prominent and successful one. It provided subsidies to grid and off-grid solar PV projects, rooting for 500MW of installed solar capacity by 2012.

As supply was increasing and increasing non-stop, prices were also falling down. These changes on the PV sector provoked different reactions that we are going to analyse in this chapter. However, the industry in China had an equal rapid decline in 2011, which was followed by a series of policies and reforms that helped it to rise again. In these years, the US and the European Union conducted some anti-dumping and anti-bribery investigations.

3.1.2 SOLAR PV ON CHINA’S FIVE-YEAR PLANS

As we previously mentioned, the first official call for the installation and use of solar PV systems was announced during the Tenth Five-Year Plan. There were previous Plans where solar energy was mentioned, but merely as a new source of energy, rather than focusing on photovoltaic projects. During the Sixth and Seventh Five-year Plan, the former State Commission of Science and Technology costs were about 4.9million yuan for renewable energy R&D, solar energy was included on these resources.²³⁰

The Tenth Plan underlined the importance of clear renewable energy, but it did not mention any specific target or investment to help the industry of solar PV to rise on the market. It was mentioned an incredible development on solar cells, with an efficiency that increased by 2% in comparison to

²²⁷ Ibid.

²²⁸ PUTTASWAMY, Nagalakshmi, ALI, Mohd. Sahil, *How Did China become the largest Solar PV Manufacturing Country?*, Center for Study of Science, Technology and Policy (CSTEP), 2015. p.2

²²⁹ ZHI et al., “China’s solar photovoltaic policy”, p.313

²³⁰ ZHI et al., “China’s solar photovoltaic policy”, p. 310

the period during the Eighth Five-year Plan.²³¹ The Notice also stated that even if the industry is going on well and technologies are developing fast, there are still some lacks and these sectors are still on the developing stage. Moreover, the 863 program was revised to make China more competitive on the global market, increasing investments on several industries. The solar PV sector was included in this new financing package.

Concerning the Eleventh Five-year Plan, targets were better defined. Incentives for the installation of solar PV in remote areas such Tibet, Qinghai, and Xingjiang were promoted following the China “Township Electrification Program” project that installed PV cells on rural areas for about 19,000KW before 2003, together with the promotion of the use of solar energy during Beijing Olympic Games, Expo Shanghai and Guangzhou Asian Games.²³² The target was to reach 50,000KW of urban solar PV systems by 2010.

We have already explained that the Strategic Emerging Industries project contains several policies aimed at the development of certain new and strategic industries that were rising in the Chinese market during also the Twelfth Five-year Plan period. In particular, the directory of new energy industry contained the solar industry, classifying it as one of the global emerging industry, instead of local. In fact, the Twelfth Five-year Plan was the best for the solar PV sector. The government had had fully recognised the potential of this industry and it started to emphasise investments and policies aimed to the development of it. China’s solar PV industry could finally compete globally, confirming the production of solar cells to be n.1 during the period of the Eleventh Five-year Plan. It was then stated that 90% of the production of these cells were to be exported, reaching a value of \$20.2billion.²³³ Moreover, the production of polycrystalline silicon increased, mastering also important technologies that could let the country compete with the rest of the world. The government also mentioned on the report an improvement on resource utilisation rate: to produce 1kg of polysilicon, before 2010 it was necessary to use 1.8-2.0kg of industrial silicon, 1.8kg of liquid chlorine, and 300-250kWh of total electricity consumption, while after 2010 1.3-1.4kg of industrial silicon, 1 kg of liquid chlorine, and 160-180kWh of total electricity consumption were

²³¹ Guojia jingmao wei 国家经贸委, guanyu yinfa 《xin nengyuan he kezaisheng nengyuan chanye fazhan “shiwu” guihua》 de tongzhi 关于印发《新能源和可再生能源产业发展“十五”规划》的通知 (Notice on the "Tenth Five-Year Plan" for the Development of New Energy and Renewable Energy Industries), *Zhonghua renmin gonghe guo zhongyang renmin zhengfu*, 2001, https://www.gov.cn/gongbao/content/2002/content_61602.htm, (Accessed July 25, 2023)

²³² Guojia fagaiwei wangzhan 国家发改委网站, 《Kezaisheng nengyuan fazhan “shiyiwu” guihua》 quanwen 《可再生能源发展“十一五”规划》全文 (Full text of the "Eleventh Five-Year Plan" for the development of renewable energy), *Guojia nengyuan ju* 国家能源局, 2011, http://www.nea.gov.cn/2011-08/22/c_131065984.htm, (Accessed July 25, 2023)

²³³ Gongye he xinxihua bu wangzhan 工业和信息化部网站, taiyang nengguangfu chanye “shierwu” fazhan guihua 太阳能光伏产业“十二五”发展规划 (12th Five-Year Plan for the Solar Photovoltaic Industry), *Zhongyang zhengfu menhu wangzhan*, 2012, https://www.gov.cn/gzdt/2012-02/24/content_2075802.htm, (Accessed July 25, 2023)

enough to produce it.²³⁴ Development goals were set to be reached by 2015. Polysilicon enterprises should reach 50,000 metric tons per year, and other major enterprises should reach 10,000 metric tons per year.²³⁵ Leading solar cell enterprises were set to reach the 5GW level, while major enterprises the 1GW level. Technologies and innovations of the sector had also room for improvement by 2015, ameliorating the conversion efficiency and the conversion rate.

Jiangsu, Hebei, Zhejiang, Jiangxi, Henan, Sichuan and Inner Mongolia were then considered clusters for solar PV production and development.

Jiangxi is an interesting example of how the concept of SEI has been implemented. The region focused on the solar PV industry, accounting for 19.6billion yuan of sales revenue in 2008. By 2015, capacity target was set to be 40,000tons of silicon materials, solar cells and other components. Sales revenues were set to be 250billion yuan worth.²³⁶ The region is the richest in terms of quartz mines, a material used for the production of crystalline silicon. This availability of raw material attracted investments and subsequently a lot of researchers and entrepreneurs that started their solar business there.²³⁷

Drafting the Thirteenth Five-year Plan for solar energy, some final remarks about the previous five years were made like every new plan. It was reported that in 2015 cumulative installed capacity reached 43.18million KW, while in 2010 it was around 86 million KW, making China the leading country in terms of cumulative installed capacity and annual new installed capacity.²³⁸ The sector grew by more than 33%, creating new job positions and reaching an output of 300 billion yuan. China was then the leader of the industry, accounting for 48% market share of polysilicon production worldwide and 70% market share of PV module production.²³⁹ Costs to produce and to buy a solar PV were both reduced, letting the “made in China” product to be dominant around the world. These data came together with the acknowledgment of a slow down on the sector due to lack of research and improvement. The Thirteenth Five-Year Plan set the goal of 110 million KW of power generation by 2020 and the drop of prices by 50%.

An important step was taken during the Fourteenth Five-year Plan, one of China’s more focused on renewable energy plan project. After the COVID-19 pandemic, it was estimated an increase on

²³⁴ Ibid.

²³⁵ Ibid.

²³⁶ Xian jingmao wei 县经贸委, Jiangxi sheng shi da zhanlve xing xinxing chanye (guangfu) fazhan gui Hua (2009-2015) 江西省十大战略性新兴产业（光伏）发展规划（2009-2015） [Development Plan of Ten Strategic Emerging Industries (Photovoltaic) in Jiangxi Province (2009-2015)], *Guang feng qu renmin zhengfu*, 2012.

²³⁷ ZHU, Xue-song, LIAO, Jin-qu, "Problems and policy recommendations to Jiangxi photovoltaic industry development.", *2010 2nd IEEE International Conference on Information Management and Engineering*, Chengdu, China, 2010, pp. 223-226. 10.1109/ICIME.2010.5478073. P.224

²³⁸ Guojia nengyuan ju 国家能源局, taiyangneng fazhan “shisanwu“ gui Hua 太阳能发展“十三五”规划 (13th Five-Year Plan for the development of Solar Energy), 2016.

²³⁹ Ibid.

wind and solar power, but specific capacity goals for these two important sectors were not mentioned in the plan. However, it mentioned a willingness to develop new plants in desert regions like the Gobi desert, promoting also the installation of solar systems on the roof of different buildings, after all, China exceeded its goal on renewable energy for the last three Five-year Plans. In 2020, average conversion efficiency of solar PV cells reached 22.8% for monocrystalline silicon cells and 20.8% for polycrystalline silicon cells.²⁴⁰

In a period of economic slowdown due to the COVID-19 pandemic and the Ukraine crisis, China did not set aside its environmental goals, by keeping its investments and policy support on these sectors. In 2020, China was reported to be first in the world in terms of cumulative installed capacity for the sixth consecutive year.²⁴¹

3.1.3 THE GOLDEN SUN DEMONSTRATION PROJECT AND THE FEED-IN-TARIFF

Policies aimed to the development of the solar PV sector can be divided into two main development processes: the initial investment (2009-2013) and subsidies for electricity generation (after 2013).²⁴² The Golden Sun Demonstration project has been extremely important for the development of the sector in China. The policy was launched by the Ministry of Finance, Ministry of Science and Technology and National Energy Administration together in 2009. The project is connected to the fact that the solar PV sector was included among the Strategic Emerging Industries during the same years. It followed another important but less impactful program named Solar Power Rooftop Subsidy Program. It provided a subsidy rate of 15 yuan/kWh and 20 yuan/kWh for rooftop solar PV and building-integrated projects.²⁴³

Subsidies have been implemented for both the national and provincial levels. It included grid connected and off-grid solar PV power generation projects, especially large projects and

²⁴⁰ Zhonghua renmin gongheguo zhongyang renmin zhengfu 中华人民共和国中央, "shisiwu" kezaisheng nengyuan fazhan guihua "十四五" 可再生能源发展规划 ("14th Five-Year" Renewable Energy Development Plan), 2023.

²⁴¹ ZHAO Sanshan 赵三珊, HUA Min 华珉, XIAO Zhiqing 肖滢青, *Quanqiu guangfu chanye fazhan ji Zhong Meiliang guo duibi 全球光伏产业发展及中美两国对比 (Global photovoltaic industry development and comparison between China and the United States)*, *Zhangjiang Technology Review*, 2022, pp. 28-31. doi:CNKI:SUN:ZJPL.0.2022-04-013. p. 29

²⁴² ZOU, Hongyang, DU, Huibin, REN, Jingzheng, SOVACOO, Benjamin K., ZHANG, Yongjie, MAO, Guozhu, "Market dynamics, innovation, and transition in China's solar photovoltaic (PV) industry: A critical review.", *Renewable and Sustainable Energy Reviews*, vol. 69, 2017, pp. 197-206. <https://doi.org/10.1016/j.rser.2016.11.053>.

²⁴³ ZHANG, Yueqi, XIE, Pengcheng, HUANG, Ying, LIAO, Cuiping, ZHAO, Daiqing, "Evolution of Solar Photovoltaic Policies and Industry in China.", *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, vol. 651, no. 2, 2021. 10.1088/1755-1315/651/2/022050. p.7.

electrification of rural areas. In fact, 50% of the total investments were aimed to on-grid projects and 70% to rural off-grid systems.²⁴⁴ The requesting party has to have a project with at least an installation capacity of 300kW, a capacity fund of more than 30% of the total investment and a total asset of no less than 100million yuan.

Applications to obtain this financial support could be asked for upfront investment subsidies in a bottom-up process, and the amount was calculated based on the project and the location.²⁴⁵ But the first step was to be taken by the local-level finance, science and technology, and energy departments, which report areas, contents and schedules to the national-level departments.²⁴⁶ Just then the national departments evaluate the whole project and agree a budget.

It is undeniable the difficulty to obtain the subsidy, and this is one of the reasons why in 2010 the program changed some targets and implemented its measures. Priority was then given to the user-side PV power generation, aiming large enterprises and public institutions. Remote areas were obviously still included, but large feed-in projects were then excluded.²⁴⁷ Approved projects doubled from 2010 to 2011, but the Golden-sun program was soon settled in early 2013, because of the impossibility to pay and approve the amount of projects that asked for subsidies in this period. Under the Golden-sun Program the ministries approved 655 projects, accounting for a capacity of 5930MW, and a total of 28billion yuan of subsidies.²⁴⁸

Nevertheless, the program led to some inefficiencies and issues on the development of the solar PV sector. First, reductions of power plan costs were promoted, and as a consequence the improvement of the quality of these also decreased. Second, it generated an overcapacity and overproduction in the market. Firms were tempted to reduce prices, but the high competition led many of them to bankruptcy.²⁴⁹

These lacks led the wrap up of the Golden-sun project and the initiation of a feed-in-tariff (FIT) to promote PV power generation. The first national-wide FIT was released by the NDRC in 2011 and was set at 1.15 RMB/kWh for project approved before its announcement and 1 RMB/kWh for later projects, except for Tibet.²⁵⁰ Power generation was divided into centralised and distributed.

Centralised power generation was divided into three regions based on the solar distribution. Funds came from fees paid by consumers on bills. These regions have different FIT levels, respectively: 0.90 yuan/kWh for regions on Zone I (Inner Mongolia), 0.95 yuan/kWh for regions on Zone II

²⁴⁴ Ibid.

²⁴⁵ FISCHER, "Green industrial policies in China".

²⁴⁶ WANG, Yonghua, LUO, Guoliang, KANG, Huang. "Successes and failures of china's golden-sun program". In: *2017 6th International Conference on Energy, Environment and Sustainable Development (ICEESD 2017)*. Atlantis Press, 2017, pp. 585-606. <https://doi.org/10.2991/iceesd-17.2017.109>. P.595

²⁴⁷ Ibid.

²⁴⁸ WANG et al., "Successes and failures of china's golden-sun program", p. 598

²⁴⁹ ZOU et al, "Market dynamics, innovation, and transition in China's solar photovoltaic (PV) industry", p.200

²⁵⁰ FISCHER, "Green industrial policies in China", p.85

(Northeast, northwest and centre of China) and Zone III 1.00 yuan/kWh (Southeast regions, including Beijing, Shanghai, Guangdong). These FIT levels should have been guaranteed for 20 years.

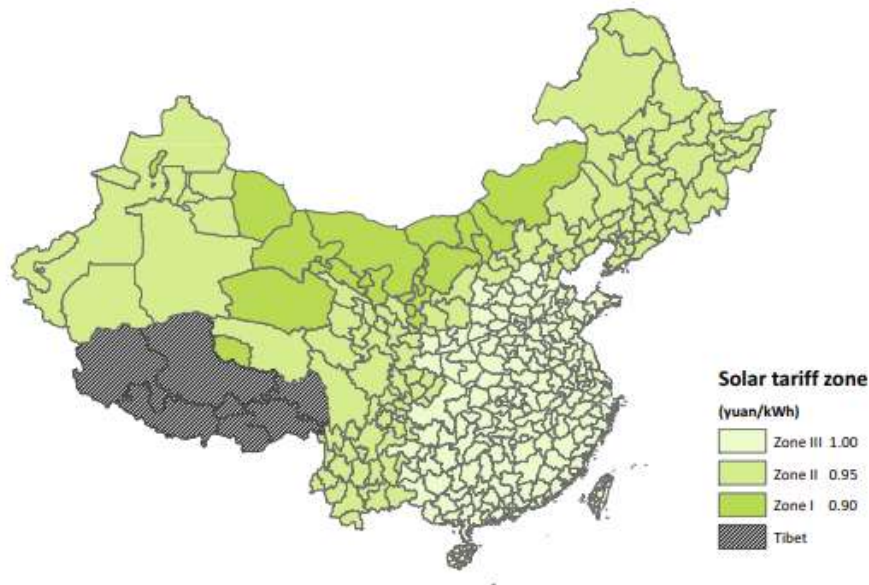


Figure 9 source: DU, TAKEUCHI, “Does a small difference make a difference? Impact of feed-in tariff on renewable power generation in China” ²⁵¹

However, in 2015 tariffs were reduced for projects approved from 2016. The note on the FIT policy announced that for regions on Zone I 0.80 yuan/kWh, 0.88 yuan/kWh for regions on Zone II and Zone III 0.98 yuan/kWh. ²⁵²

During these years, FITs were gradually reduced. In 2017 Tibet was included for the first time, with a rate of 1.05 yuan/kWh. In 2019, just to give an example, Zone I had a tariff of 0.40 yuan/kWh, 0.45 yuan/kWh for regions on Zone II and Zone III 0.55 yuan/kWh. It is actually really interesting that this FIT really worked. In 2013 there was a surplus of installations, and so the government set an installation quota for each region to limit excessive subsidies and projects.

In 2021, the NDRC announced the suspension of FITs for most PV and wind projects. As regards PV projects, FITs are still present for concentrating solar power, whose tariffs are paid by the local government.

²⁵¹ DU, Yimeng, TAKEUCHI, Kenji, “Does a small difference make a difference? Impact of feed-in tariff on renewable power generation in China”, *Energy Economics*, vol. 87, 2020. <https://doi.org/10.1016/j.eneco.2020.104710>

²⁵² YE, Liang-cheng, RODRIGUES, João F.D., LIN, Hai Xiang, “Analysis of feed-in tariff policies for solar photovoltaic in China 2011–2016”, *Applied Energy*, vol. 203, 2017, pp. 496-505. <https://doi.org/10.1016/j.apenergy.2017.06.037>. P.498

3.1.4 SOLAR PV ON MIC 2025

We have explained that the main goal of the MIC 2025 program is to change how the world sees products made in China and to increase the presence of digital and technology-focused manufacturing.

As regards the solar PV sector, efficiency goals were set for both mono- and polycrystalline silicon cells, improving them by 101.5% and 103% respectively.²⁵³ There is also a target concerning cadmium telluride thin-film cells, increasing its efficiency by 20%, and 21% for CIGS thin-film cells. Efficiency should exceed 43% for III-V compound solar cells, perovskite solar cells, dye-sensitized solar cells, organic solar cells, quantum dot solar cells, stacked batteries and high-efficiency gallium arsenide batteries.²⁵⁴ Investments on new technologies concern also inverter systems, developing also new smart inverters.

In 2016, the Chinese Ministry of Industry and Information Technology (MIIT) issued the Made in China 2025 Energy Equipment Implementation Plan. The Plan aims at the promotion of R&D on energy equipment independency, being also at the competitiveness of the sector worldwide.

Digitalisation is also connected with renewable energies. The Chinese government recognised on the internet the possibility of increasing a comprehensive monitoring, prediction and analysis of these data. Big data can predict malfunctions and control maintenance of photovoltaic systems, as well as wind turbines, without the intervention of a human being. By 2020, this sector should realise its independence from equipment export, while by 2025 the sector should be able to compete on the international market with new advantageous technologies.²⁵⁵

Even though solar power is not the main industry of the MIC 2025 project, we can notice how it is a constant factor of innovation concern. In fact, one of the main drivers of this industrial project is the amelioration of energy efficiency and the reduction of pollution levels of the manufacturing industry in China.²⁵⁶ As a relatively new project divided also into three steps, it is difficult to predict its outcomes and effectiveness, but the project and its targets are surely promising also when talking about the role of solar PVs.

²⁵³ Guojia fazhan gaige wei 国家发展改革委, gongye he xinxihua bu 工业和信息化部, guojia nengyuan ju 国家能源局, Zhongguo zhizao 2025 --- nengyuan zhuangbei shishi fangan 中国制造 2025—能源装备实施方案 (Made in China 2025—Energy Equipment Implementation Plan), 2016, <https://www.gov.cn/xinwen/2016-06/21/5084099/files/f64a4db485544bbdaf136fc6cbdf70ff.pdf>

²⁵⁴ Ibid.

²⁵⁵ Ibid.

²⁵⁶ XU, “Towards Green Innovation by China’s Industrial Policy: Evidence From Made in China 2025”, p.2

3.1.5 FUTURE PERSPECTIVES

Chinese photovoltaic industry had an enormous growth both bringing positive and negative new aspects on the Chinese market and economy.

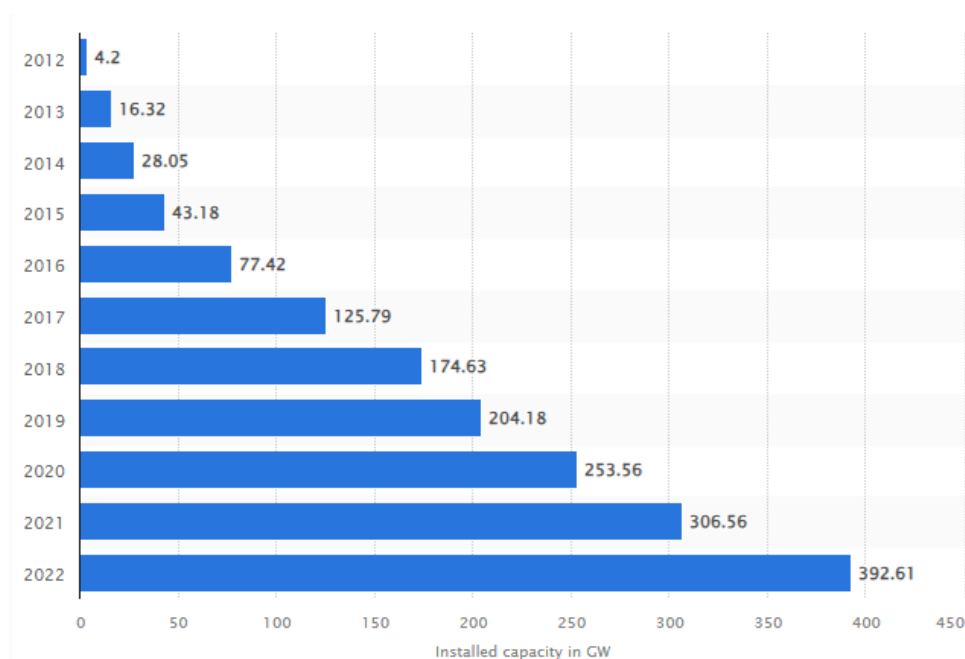


Figure 10 source: Statista²⁵⁷

As we went through China’s installed solar power capacity during the years, we observe a gigantic improvement, even surpassing its own goals. In fact, the country surpassed its total installed capacity goal for 2020 three years before.²⁵⁸ As the sector has reached its goals, a new one came out: to reach grid parity. Grid parity is when energy produced through photovoltaic costs are equal to prices of using conventional sources of power such as coal.

After the abolishment of the FIT, new solar PV installation projects declined as many companies were dependent on it. The “531” policy announced in 2018 had the mitigation of supply-chain problems that were persisting on the solar PV industry as core centre, but it also gave priority to the development of new technologies concerning the industry.²⁵⁹ Thanks to this policy, the PV installation capacity was expected to decline to 40GW in ten years. Because there were less subsidy,

²⁵⁷ FERNANDEZ, Lucia, “Cumulative installed solar power capacity in China from 2012 to 2022(in gigawatts)”, Statista, 2023, <https://www.statista.com/statistics/279504/cumulative-installed-capacity-of-solar-power-in-china/>, (Accessed August 2, 2023)

²⁵⁸ ZHANG et al., “Evolution of Solar Photovoltaic Policies and Industry in China”, p.1

²⁵⁹ ZHANG et al., “Evolution of Solar Photovoltaic Policies and Industry in China”, p.14

prices of components declined and projects remained unfinished. Nevertheless, the country was able to meet its goals and reduce solar installed capacity to 44GW in 2018.²⁶⁰

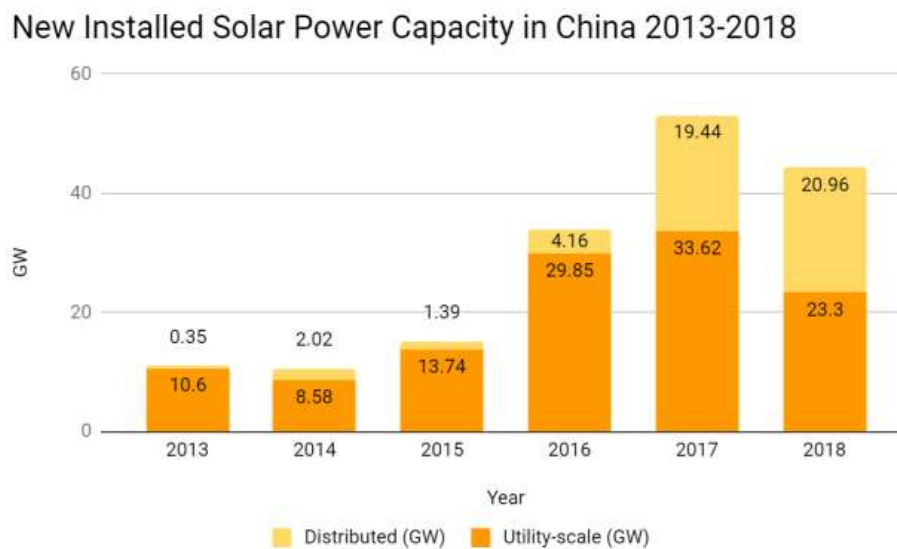


Figure 11 source: China Renewable Energy Industry Development Report 2018; National Energy Agency

The 531 policy continued in 2019, causing another decrease in total new solar installation capacity, reaching a bit more than 30GW. However, photovoltaics’ newly installed capacity was still the largest.²⁶¹ On the same year, the government also lowered the value-added tax from 16% to 13%. Jumping to 2021, the total installation capacity of solar PV reached 54.88GW, growing for the second year in a row (in 2020 it was 48.2GW).²⁶² This trend is caused by the fact that the new target of carbon neutralisation by 2060 was announced by President Xi Jinping. In 2021, China’s production of polycrystalline silicon material was accounting for 80.5% of the worldwide production, and an output of 78.8% in global terms. As regards solar cells, Chinese production accounted for more than 85% of global production. PV modules production also took a great slice of the solar PV market, accounting for 86.6% of global export.²⁶³ 2022 was also an amazing year in terms of export and production of components and whole products concerning solar photovoltaics. Chinese PVs are mainly sold to European countries,

²⁶⁰ JACKSON, Margaret, “Chinese Solar Shines at Home and on the Road”, New Security Beat, 2019, <https://www.newsecuritybeat.org/2019/03/chinese-solar-shines-home-road/>, (Accessed August 3, 2023)

²⁶¹ FANG, Lyu, XU, Honghua, WANG, Sicheng, LI, Hailing, YU, Yang, “National Survey Report of PV Power Applications in China 2019”, International Energy Agency (IEA), 2019. https://iea-pvps.org/wp-content/uploads/2020/09/NSR_China_2019.pdf. P.5

²⁶² FANG, Lyu, XU, Honghua, YU, Yang, “National Survey Report of PV Power Applications in China 2021”, International Energy Agency (IEA), 2021. <https://iea-pvps.org/wp-content/uploads/2022/11/PVPS-National-Survey-Report-China-2021.pdf>. p.5

²⁶³ FANG et al., “National Survey Report of PV Power Applications in China 2021”, p.23

accounting for 46% of total export, especially when it comes to modules. Cumulative installed capacity reached 87.4GW, setting a new record even if the target was of 108GW.

The China Photovoltaic Industry Association (CPIA) estimated the country to reach 100-125GW of installation capacity by 2025, underlying the effort of the government to reach the carbon neutrality goal. Meanwhile, the country is to continue with the energy goals announced on the Fourteenth Five-year Plan.

3.2 COMPETITION ON THE SOLAR PANEL INDUSTRY

In a globalised world, where every type of information, product, service is possible to be reached and to delivered to another country, it is inevitable that competition among companies that produce, deliver, offer the same thing do exist. We have analysed on the previous chapter what is competition and how countries on our interest deal with it through policies and laws.

China has been the leader on solar PV production for several years, and this caused a reaction from other countries that held primacy on the market before China. The US has always been an important centre of research and development of new photovoltaic technologies, and it's the third country on installed capacity of solar power. The European Union is the second on these terms, with Germany as a leader before China's entrance on the global market. Germany is actually the first country to have introduced FIT for renewable energy. Italy has also an important slice of the European market of solar PV energy. It was the third market after Germany and Spain during the 2010s. In January 2023, Germany counts 57 companies that produce solar PVs, followed by France (22). Italy takes the fourth position together with Spain counting 18 companies.²⁶⁴ These data are supposed to get better, as Europe announced its willingness to reduce dependence on Russian natural gas, and invest more on renewable local resources such as solar power.²⁶⁵

It is interesting to analyse different policies applied on different countries and compare their results with the target set during the years. We will notice how different countries, and governments, see and treat the solar PV potential. It is important to remember that differences on solar power capacity are caused by different solar capacity, in particular when comparing it to China that has an enormous solar potential.

Competition on the solar PV industry also went through trade disputes, it is considered one of the biggest controversy between China and the EU of all times. Same was with the US, where controversies were many and went on several years, suffice is to know that some aspects are still debated today. These disputes defeated the Chinese industry for some years, but it regained power rapidly and it still is now the biggest exporter of solar PV components and materials.

We are going to start this brief analysis with Italy, then Germany and the US. We then move to the examination of trade disputes the solar PV industry between China, the EU and the US. It is

²⁶⁴ FERNANDEZ, Lucia, "Number of solar PV manufacturing companies in the European Union as of January 2023, by country", Statista, 2023, <https://www.statista.com/statistics/1362248/solar-pv-manufacturing-companies-by-country-eu/>, (Accessed August 7, 2023)

²⁶⁵ SCHMITZ, Rob, "China dominates the solar power industry. The EU wants to change that", NPR, 2023, <https://www.npr.org/2023/05/17/1173250926/solar-power-eu-germany-china>, (Accessed August 8, 2023)

interesting to see how the two disputes differ, also taking into account differences on the views over competition described on the first chapter of this thesis. Finally, some future perspectives and predictions are made, considering also the fact that these countries are extremely reliant on each other when talking about the photovoltaic industry.

3.2.1 PHOTOVOLTAICS IN ITALY

Before we discuss competition on solar PV between China and Italy as part of the European Union, it is necessary to analyse briefly the development of this sector in our country.

In Italy, first photovoltaic projects and consumptions of solar energy began in 2005 with a rising awareness over climate change and incentives from the European Union that helped the improvement and the quick development of the sector. Italy has also a great level of solar irradiation, actually it is one of Europe's sunniest country, and so this type of renewable energy has always been considered one of the most prominent one.

The development started with the "Conto Energia" program, which was a sort of FIT provided by the government that rewards people for the production of their solar PV for about 20 years. By doing this, installations of solar PV on private homes, factories and other buildings increased enormously, making Italy one of the leader in solar PV installation capacity. In 2018, Italian added solar PV capacity reached 437MW.²⁶⁶

However, this sector did not have a strong development during these last years, and so the government introduced another program called "SuperBonus 110%" that included a tax reduction of 50%. Results of this program, that is still into force, were seen on the latest data of 2022.

Installations of solar PV increased by 20.6% in comparison to the previous year.²⁶⁷ Experts expect an exponential growth of installations, focusing on regions where solar potential is great (e.g. Sicily, Apulia). In fact, Italy has created numerous solar PV plants on its territories. The biggest one is located in Apulia. The Troia Solar PV Park was commissioned in 2019 and produces 121.5MW every year.

So we notice that the Italian solar PV industry is promising, especially if we focus on results of these years that transformed the sector to one of the most flourishing in the country and a field where Italy can compete on the world. However, it is still lacking on the production of components

²⁶⁶ "Solar Energy in Italy", Solar Feeds, <https://www.solarfeeds.com/mag/wiki/solar-energy-italy/>, (Accessed August 5, 2023)

²⁶⁷ ROMA, Alfonso, "GSE: pubblicato il rapporto 2022 sul fotovoltaico", BibLus-net, 2023, <https://biblus.acca.it/gse-report-rinnovabili/>, (Accessed August 5, 2023)

and tools for the creation of the amount of solar energy that the country is producing. Italian factories which produce solar PV components are about 234, accounting for 58.8% of Italian components on the Italian market.²⁶⁸ The dependency on China regarding solar PV components is increasingly worrying, as we are facing several crisis already cited in this thesis. Italy is facing this lack on production with a new project: 3Sun Gigafactory. This project is considered the largest solar factory in Europe. The installation should be finished by 2024 and it is expected to produce around 3GW every year. A total investment of 600million euros has been allocated, with 188million euros provided by the EU.

3.2.2 PHOTOVOLTAICS IN GERMANY

Germany has a longer story with the manufacturing of solar PV. As one of the first countries to reach a cumulative installed capacity of 1GW in 2004, the country has increasingly improved solar technologies and allocated higher investments to become one of the biggest producers worldwide. In the late 1970s, Germany invested huge amounts on R&D subsidies to solar research institutes. The following 20 years the government introduced a policy that implies coverage for 70% of the costs of installation of solar PV on private households.

Germany was then the first country in Europe to introduce a feed-in-tariff with the Renewable Energy Act (Erneuerbare-Energien-Gesetz, EEG) for solar installations. The tariff was amended several times, from year 2000 until 2014 when it was drastically reduced, from 0.50euro/kWh in 2008 to 0.10euro/kWh. In fact, the revised Renewable Energy Sources Act published that year stated that EGG should no longer be decided by the government but by auction. This led to a significant decrease of new installations, but it soon increased later on due to the high demand of German technologies. In fact, the country has huge investments on internal R&D and cooperation with universities and institutes.

Germany is also one of the biggest producer of solar power batteries in Europe, producing almost 58.5MW in 2021 and taking the fourth place on global production after China, the United States and Japan.²⁶⁹ But this was not enough. The demand was getting higher and it was difficult for the internal production to satisfy it, so Germany turned to import cheap solar PV component from China, helping the country to become a giant on the market. Since the reduce of incentives for solar

²⁶⁸ "Fotovoltaico: in Italia il 60% dei fornitori è italiano", Industry Weekly, 2023, <https://industryweekly.it/industry-weekly-attualita/industry-weekly-attualita-industria/fotovoltaico-in-italia-il-60-dei-fornitori-e-italiano/14/33/>, (Accessed August 5, 2023)

²⁶⁹ "Solar Power by Country 2023", World Population Review, <https://worldpopulationreview.com/country-rankings/solar-power-by-country>, (Accessed August 7, 2023)

PV installations in 2013, the market gradually shifted to China, that started to invest 10 times more than Europe.²⁷⁰

Data from 2008 show that among the top 10 solar cell equipment companies, 6 were German. “Roth & Rau AG” sold 275million dollars of equipment, following the first company on the list “Applied Materials” from the US.²⁷¹

We can easily state that Germany has been greatly impacted by the rising dominance of China in the solar PV sector. In 2022, around 95% of solar cells installed in Germany came from China, causing a too high reliance on the country.²⁷² However, Germany is still one of the biggest market when it comes to solar PVs. In 2021, Germany’s total solar power output reached 5.3GW, and it is expected to get better in 2023. In fact, new solar power installed capacity is expected to reach a total of 9 to 11GW, in 2022 it was 7.2GW.²⁷³ To realise these expectations, Germany renewed its EEG to increase new FITs but in two separate ways. For instance, prices will also raise from 0.07euro/kWh to 0.08euro/kWh for systems up to 10kW.²⁷⁴ The difference that is visible here is that the German government focused almost only on the demand side of the industry, while China had also great initiatives reserved for the supply side. The only measures taken for the support of the supply side in Germany have been tax exemptions and breaks for small-scale PV systems.²⁷⁵

Recently, China and Germany agreed for a “Climate and Transformation Dialogue” to focus on cooperation on the fight against climate change and help the development of a most sustainable environment, signing a Memorandum of Understanding on 20th June 2023.

3.2.3 PHOTOVOLTAICS IN THE US

The United States of America are the pioneers of solar technology, as already mentioned. First solar panels were developed and manufactured in the US, and were the most prominent source of power as oil prices rose drastically in 1970s. After that, several technological advancement have been

²⁷⁰ SCHMITZ, “China dominates the solar power industry.”

²⁷¹ DUNFORD, Michael, LEE, Kyoung H., LIU, Weidong, YEUNG, Godfrey, “Geographical interdependence, international trade and economic dynamics: The Chinese and German solar energy industries”, *European Urban and Regional Studies*, vol. 20, 2013, pp. 14-36. <https://doi.org/10.1177/0969776412448093>. p.22

²⁷² WEHRMANN, Benjamin, “Germany’s solar power industry worried by dependence on Chinese suppliers”, *Clean energy Wire*, 2022, <https://www.cleanenergywire.org/news/germanys-solar-power-industry-worried-dependence-chinese-suppliers>, (Accessed on August 7, 2023)

²⁷³ “Germany’s photovoltaic system demand set for double-digit growth this year, lobby says”, *Reuters*, 2023, <https://www.reuters.com/business/energy/germanys-photovoltaic-system-demand-set-double-digit-growth-this-year-lobby-says-2023-06-13/>, (Accessed August 8, 2023)

²⁷⁴ WILLUHN, Marian, “Germany raises feed-in tariffs for solar up to 750 kW”, *PV Magazine*, 2022, <https://www.pv-magazine.com/2022/07/07/germany-raises-feed-in-tariffs-for-solar-up-to-750-kw/>, (Accessed August 8, 2023)

²⁷⁵ ZHI et al., “China’s solar photovoltaic policy: An analysis.”, p.317

made, but the industry was still not producing and installing a lot of solar systems. The US is home of the first concentrated solar power plant: Solar Energy Generating Systems (SEGS) built in California in 1984. In 2007, American installed 342MW of solar PV power, while on the same year China installed just 20MW. Solar energy became increasingly important on the American market, accounting for 2.3% of total electricity generation in 2019, in 2010 it was 0.1%.²⁷⁶ On the same year, the Solar America Initiative was introduced and provided more than \$13.7million to research and development of the solar PV industry.

Huge investments are made also by the US Department of Energy (DOE) that takes care of the sector. In 2011, it introduced the SunShot Initiative, established to reduce solar energy costs. The latest policy is the Inflation Reduction Act (IRA) of 2022, a federal program that has the acceleration of the transition to renewable energy as the main goal. Taxpayers can deduct a percentage of the costs of the new solar system from their federal taxes thanks to the new Investment Tax Credit, firstly published in 2005, and the Production Tax Credit.

China and the US have a long history of disputes, and the solar PV sector is no exception. Even though the US are offering subsidies to local photovoltaic companies, Chinese imports are still dominant when it comes to low prices. We can easily agree that the intent of the US to reach solar modules independence by 2026 won't be met, this is also clear after the path of the dispute with China on the sector that is analysed below. Modules produced in China cost an average of 57% less than those produced in the US, and in Europe.²⁷⁷ But what is interesting is that China is not the bigger exporter in the US. In the first quarter of 2023, 30% of US imports of solar panels came from Vietnam and, together with Thailand, Malaysia and Cambodia, it accounted for 79% of imports.²⁷⁸ For a reference, less than 30% of solar panels and modules installed were produced domestically.²⁷⁹ The fact is that China is moving part of its manufacturing to these countries for several reasons. However, the Biden administration suspended tariffs over solar panels import from these countries until 2024, a suspension that caused perplexities, since China was benefitted. Some American manufacturers are convinced that China moved its production to these countries to avoid US anti-

²⁷⁶ O'ROURKE, Rebecca, "Powering the Nation: The Benefits and Challenges of US Solar Energy", NES Fircroft, 2023, <https://www.nesfircroft.com/resources/blog/powering-the-nation--the-benefits-and-challenges-of-us-solar-energy/>, (Accessed August 9, 2023)

²⁷⁷ SHETTY, Satish, "Chinese Low-cost Solar Exports Challenge US, EU and India Reshoring Policies", MERCOM, 2023, <https://www.mercomindia.com/chinese-low-cost-solar-exports-challenge-us-eu-india-reshoring-policies>, (Accessed August 10, 2023)

²⁷⁸ NGUYEN, Trang, "Vietnam accounts for 30% of US solar panel imports in Q1", The Investor, 2023, <https://theinvestor.vn/vietnam-accounts-for-30-of-us-solar-panel-imports-in-q1-d5023.html>, (Accessed August 10, 2023)

²⁷⁹ DALY, Matthew, "Biden vetoes bid by Congress to reinstate tariffs on solar panel imports from SE Asia", AP News, 2023, <https://apnews.com/article/solar-tariffs-biden-china-imports-climate-56582d84c0d369cdb01b774dc15d61ee>, (Accessed August 11, 2023)

dumping rules, but to meet its climate goals, Biden stated that the country needed the foreign supply chain.²⁸⁰

This competition went also through disputes that we are going to analyse here below. The Biden administration is still working on new anti-dumping measures on Chinese imports, whether it is about solar panels and its components or not. We understand that this is not only about competition on the economic aspect of a country, but also a little bit political, as one of the reason to justify these type of measures is the exploitation of Uyghur on Xinjiang (China). In fact, the Uyghur Forced Labour Prevention Act (UFLPA) has been effective since 2022 and it aims at the ban of the import of products manufactured in this region, the majority of which seems to be solar panels.²⁸¹ In fact, production of polysilicon in Xinjiang account for 50% of the whole supply chain, as we have seen that the region is rich resource-wise. Groom (2022) explains on *Reuters* that 1.000 solar shipments were blocked in the American frontier.²⁸² As this is a relatively new act, we still do not know its real impact on the long-term, but we agree that Chinese solar exports to the US is destined to decrease, leaving space to other countries or, as the American government wishes, to local manufacturers.

3.2.4 THE DISPUTE BETWEEN THE EUROPEAN UNION AND CHINA

The European Union has a long history of environmental goals. Renewable energies have always been seen as a fundamental tool for the fight against climate change. The European Union needed a lot of solar installations, and it took advantage of the Chinese imports that costed less than the domestic production. China has been increasingly important for the energy transaction in the EU. However, on June 2012 a petition was submitted to the European Commission. A group of solar panel producers named EU ProSun claimed to be largely affected by their competitive rivals from China. Among these companies, the giant Solar World Germany, that was reported to have lost about 500million euros in 2012.²⁸³ In fact, more and more European solar companies were announcing bankruptcy or were being bought by Chinese investors also through M&A, signalling

²⁸⁰ Ibid.

²⁸¹ VALENSTEIN, Carl A., WEAVER, Casey, “How Responsible Labor and Trade Issues Affect the Solar Energy Industry”, Morgan Lewis, 2023, <https://www.morganlewis.com/blogs/powerandpipes/2023/02/how-responsible-labor-and-trade-issues-affect-the-solar-energy-industry>, (Accessed August 13, 2023)

²⁸² GROOM, Nichola, “Exclusive: U.S. blocks more than 1,000 solar shipments over Chinese slave labor concerns”, Reuters, 2022, <https://www.reuters.com/world/china/exclusive-us-blocks-more-than-1000-solar-shipments-over-chinese-slave-labor-2022-11-11/>, (Accessed August 13, 2023)

²⁸³ CHAFFIN, Joshua, “EU solar-panel makers file China lawsuit”, Financial Times, 2012, <https://www.ft.com/content/5e8939fc-072e-11e2-b148-00144feabdc0>, (Accessed August 13, 2023)

that the country was gaining a monopolistic position on the market. Subsequently, the Alliance for Affordable Solar Energy (AFASE) was founded to oppose tariffs over Chinese imports, protecting the right of free solar energy trade. We specify here that EU ProSun members are mainly manufacturers of wafers, cells, and modules, while AFASE represented upstream producers and downstream installers and retailers.²⁸⁴ The European Photovoltaic Industry Association (EPIA) represented both sides, so it stayed neutral at the beginning of the dispute.²⁸⁵ Not only coalitions, but also European governments were divided on the effectiveness of tariffs. Surprisingly, German Chancellor Angela Merkel stated that a political resolution was preferred, same was for Swedish and the UK governments. Other important markets for solar power, namely Spain, Italy and France, were in support of tariffs against Chinese imports. Some firms and governments centred their discourses against China over the fact that Chinese products do not have good quality and technologies. Moreover, the fact that several companies were closing because of this unfair competition, people were losing their jobs.

The European Commission then started, on September 2012, with the investigations over competition among companies from Europe and China, to define if imported solar PV cells, wafers and modules from China are actually sold at dumped prices or not. At that time, trade was estimated to be worth 21 billion euros, accounting for 6.4% of Chinese goods exports to the EU.²⁸⁶

Of course, the reaction of Chinese entities and government were not positive. Subsequently, the Chinese Ministry of Commerce announced an investigation on European imports of polysilicon. At that time, Germany was one of the biggest producer and exporter of this component, accounting for 16% of the total global production.²⁸⁷ China reported that four local companies, namely Jiangsu Zhongneng Silicon Technology Development Co. Ltd., Jiangxi LDK Photovoltaic Silicon Technology, Luoyang China Silicon High-tech, and Daqo New Energy suffered from imported polysilicon prices. Among these European companies that were reported to damage local firms there were the German Wacker Chemicals and the Italian MEMC Electronic.²⁸⁸

²⁸⁴ GORON, Coraline, “Fighting against climate change and for fair trade: finding the EU’s interest in the solar panels dispute with China”, *China-EU Law Journal*, vol. 6, 2018, pp. 103-125. <https://doi.org/10.1007/s12689-018-0080-z>. P.106

²⁸⁵ Ibid.

²⁸⁶ BRADSHER, Keith, “Europe Investigates Chinese Solar Panels”, *The New York Times*, 2012, <https://www.nytimes.com/2012/09/07/business/global/eu-investigates-chinese-solar-panels.html>, (Accessed August 13, 2023)

²⁸⁷ HOOK, Leslie, “China to probe EU solar imports”, *Financial Times*, 2012, <https://www.ft.com/content/e6eff638-23e3-11e2-94d0-00144feabdc0>, (Accessed August 14, 2023)

²⁸⁸ WANG You 王佑, *Zhongguo dui Oumeng duojingui shuangfan diaocha luodi – Deguo Wake tiaoguo yi jie 中国对欧多晶硅双反调查落地 德国瓦克逃过一劫 (China’s anti-counterfeiting investigation into European polysilicon comes to an end, Germany’s WACKER escapes harm)*, *Sina xinlang caijing*, 2014, <http://finance.sina.com.cn/chanjing/cyxw/20140505/015018996747.shtml>, (Accessed August 15, 2023)

But this was just the beginning. On November 2012, China reported to the WTO that Italy and Greece had unfairly policy measures as regards solar power and solar panel production. A meeting between Angela Merkel and Li Keqiang was held to jointly criticise the dispute sustained by the European Commission, preferring dialogue and consultation.²⁸⁹

However, on March 2013 the European Commission launched an investigation on solar glass imported from China, continuing its pressure on the competition on this particular sector. This investigation was defined by the Commission itself as something different and not related to the dispute over the solar panel industry. Besides, it did not receive any anti-subsidy complain.

On June 2013, the European Commission announced that evidences were found and anti-dumping duties were to be set. Investigations showed that imports from China resulted in dumping margins of 88% circa, in some cases it was even higher.²⁹⁰ Specifically, the Golden Sun Programme was considered as one of China's most dangerous subsidy program for the rest of the world, because it gave excessive help to local producers, letting them becoming highly competitive worldwide.

It was then decided on June 2013 to impose for the first two months a provisional duty, then duties between 37.3% and 67.9% were to be paid.²⁹¹ These duties could be lowered to those Chinese companies that decided to cooperate, and the WTO approved them. In fact, on December 2013, official duty rates were published and there was a distinction between companies which collaborated on the investigations and which did not.

These anti-dumping duties were highly criticized by different member countries of the European Union, accusing the Commission of damaging Europe's climate policy and hurting European solar PV companies. Given these protests and China's menace to impose tariffs on European wine imports, the European Commission decided to lower the duties with a 11.8% discount, in order also to facilitate discussion over a possible solution. This was followed by several negotiations and meetings between the European Commission and the China Chamber of Commerce for Import and Export of Machinery and Electronic Products (CCCME) with the aim of setting minimum prices for solar products imported from China. The minimum price was set at 0.56euro/Watt and it would have being kept for the next two years. This led all the probes raised by China to fell and be dismissed, signalling a willingness to collaborate and to reduce trade disputes for the long term. However, the dispute was still not completely settled. In 2015, the European Union found a violation of the minimum selling price of three Chinese companies, namely Chinese-Canadian

²⁸⁹ Ministry of Foreign Affairs of the People's Republic of China, "Premier Li Keqiang and German Chancellor Angela Merkel Hold Joint Press Conference", 2013, https://www.fmprc.gov.cn/mfa_eng/gjhdq_665435/3265_665445/3296_664550/3298_664554/201308/t20130815_575571.html, (Accessed August 14, 2023)

²⁹⁰ European Commission, "MEMO: EU imposes provisional anti-dumping duties on Chinese solar panels", June 2013, Brussels, https://ec.europa.eu/commission/presscorner/detail/en/MEMO_13_497 .

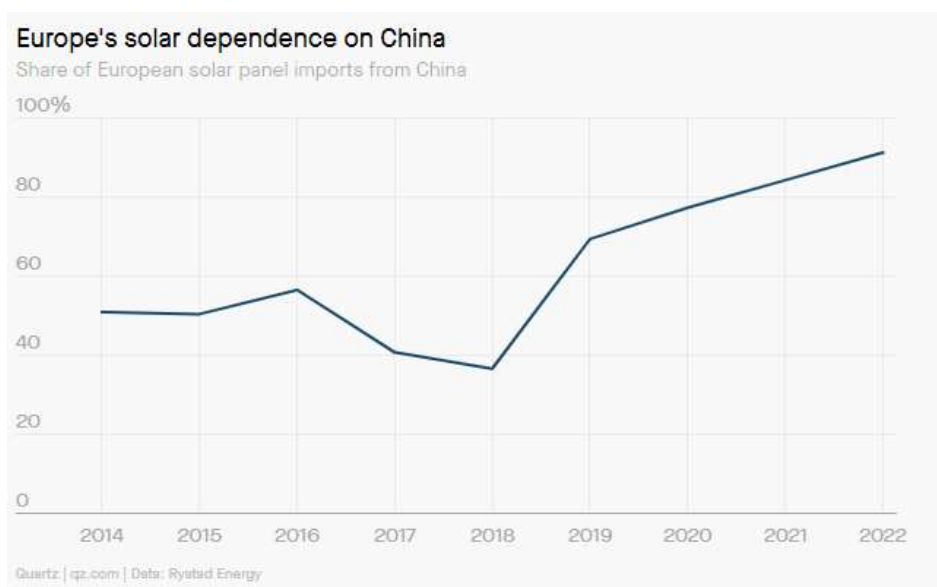
²⁹¹ Ibid.

Canadian Solar, ReneSola and ET Solar. Luckily, the story had an happy ending and in 2018 the EU stopped tariffs and minimum import price measures on Chinese solar panels.

Europe has demonstrated, and admitted, that it is too dependent on Chinese solar PVs, as it is the largest consumer market of solar power, and China is the largest producer. When the dispute was raised, little relevance was given to the environmental factor. Goron (2018) reported that at that time, several meetings were to be held in order to help facilitate global collaboration on climate change, for example the elimination of tariffs for goods addressing climate change, including solar PV.²⁹² So we can argue that the European Commission and those companies that started the dispute over Chinese solar panel imports had the motivation to do so, but several aspects of the dispute should be analysed first. Once again the question was raised: which one has the priority?

Competition or green goals? For those who voted in favour of duties against China, maybe we can conclude that competition was the priority. They argued that, because of China, numerous jobs were lost, especially those in engineering and manufacturing fields that moved to China. They complained that, because of highly competitive prices, Chinese solar companies were too dominant on the market, squeezing European companies that were unable to meet this new standard of prices.

Of course, we are not standing with unfairness, but the green goal should not be set aside. As the largest consumer of solar power, Europe should find a balance and activate policies to boost this sector locally, but not undermining imports which are essential for the market. This phenomenon has been confirmed in these years, where Europe realised how dependent it is from energy imported from Russia.



²⁹² GORON, “Fighting against climate change and for fair trade”, p. 121

It is interesting to notice that China PV export volumes has been impacted by European duties, but in 2018, as soon as the dispute ended, the country regained its primacy on the sector.

While Europe dependence on Russia fossil fuels dropped to 88% between 2021 and 2022, China became fundamental for the development of the green goals set by the EU.²⁹⁴ This is highly recognised by different European institutions and governments. Dutch trade minister Liesje Schreinemacher (2023) stated that green transition in Europe will be impossible without China.²⁹⁵ Same was revealed by the German government led by Chancellor Scholz (2023), who underlined that China plays an important role on the fight against climate change.²⁹⁶

3.2.5 THE DISPUTE BETWEEN THE US AND CHINA

China's solar primacy was contested also in the US. No surprise, we can say, as the two countries have always had important disputes over economic factors and dominance. In 2011, the American subsidiary of the German Solar World, which thereafter also raised the dispute in Europe, and the Coalition for American Solar Manufacturing (CASM) claimed through a petition to the US DoC and the US International Trade Commission (ITC) that Chinese solar manufacturers were gaining market share through dumping measures. In particular, the CASM accused China to cheat on global trade rules and its impeding the American solar manufacturers to grow.²⁹⁷ The accusations were raised on a period where anti-China sentiments were growing, and the administration at that time led by former President Obama was being accused of lack of efforts as regards local renewable energy companies.²⁹⁸ Investigations began almost immediately and in October 2012 the US Department of Commerce announced anti-dumping duties to be around 18.3% and 250% and

²⁹³ HUI, Mary, "Europe's latest energy security tactic: hoarding Chinese solar panels", Quartz, 2023, <https://qz.com/europe-s-latest-energy-security-tactic-hoarding-chines-1850659750>, (Accessed August 15, 2023)

²⁹⁴ BROWN, Alexander, "Net-zero Europe risks a heavy dependence on China", Merics, 2022, <https://www.merics.org/en/comment/net-zero-europe-risks-heavy-dependence-china>, (Accessed August 16, 2023)

²⁹⁵ HANCOCK, Alice, BOUNDS, Andy, "Europe's green transition impossible without China, says Dutch minister", Financial Times, 2023, <https://www.ft.com/content/c080d5fa-395a-4611-b08f-4d5e8e2b28b8>, (Accessed August 16, 2023)

²⁹⁶ ZIADY, Hanna, SCHMIDT, Nadine, "'China has changed.' Germany unveils strategy to cut reliance on world's no. 2 economy", CNN, 2023, <https://edition.cnn.com/2023/07/13/economy/germany-china-strategy/index.html>, (Accessed August 16, 2023)

²⁹⁷ WESOFF, Eric, "China-US Solar Trade War: CASE vs. CASM", GTM, 2011, <https://www.greentechmedia.com/articles/read/china-us-solar-trade-war-case-vs-casm>, (Accessed August 17, 2023)

²⁹⁸ BRADSHER, Keith, "U.S. Solar Panel Makers Say China Violated Trade Rules", The New York Times, 2011, <https://www.nytimes.com/2011/10/20/business/global/us-solar-manufacturers-to-ask-for-duties-on-imports.html>, (Accessed August 17, 2023)

countervailing duties to be around 14.8% and 16%.²⁹⁹ The fact was that these duties were just affecting solar panels made by Chinese solar cells, and this led some Chinese companies to avoid duties through outsourcing to Taiwan.³⁰⁰ In fact, as stated before, China started to move its production to other Asian countries such as Vietnam, Indonesia and of course Taiwan was included. This phenomenon led Solar World to rise another petition against Chinese solar PV manufacturers, and in 2014 new investigations began. This time, anti-dumping duties were set around 26.7% and 78.4% for Chinese solar panels, around 11.5% and 27.6% for solar cells imported from Taiwan and duties for Chinese modules were set to be around 27.6% and 49.8%.³⁰¹ The Coalition for Affordable Solar Energy (CASE) has been against anti-dumping duties against China since the beginning of the dispute. CASE's members support the idea that these duties could put under pressure the American solar industry by raising panel prices for both manufacturers and final consumers. However, Solar World was still winning its dispute, resulting as one of the victims of cyber espionage conducted by five members of the Chinese People's Liberation Army.³⁰² Solar World reported to have its cash flow, manufacturing metrics and other information hacked, and these information let a Chinese competitor to target the German manufacturer.³⁰³

These accusations, of course, caused a reaction from China. In 2012, MOFCOM started its investigations on polysilicon imports from the US and the Republic of Korea. It subsequently released duties around 57% for some American companies.³⁰⁴ These duties were then confirmed in 2014 and lasted for five years.

History is not concluded here, as ITC revealed in 2018 that a tariff of 30%, called Section 201, would have been applied on solar cells and modules imported from China. This tariff was planned to decrease to 15% in 2021, allowing 2.5GW of unassembled solar cells to be sold in the US every year without a tariff imposition.³⁰⁵ Eventually, the American President at that time Donald Trump

²⁹⁹ PALMER, Doug, "U.S. sets steep final duties on Chinese solar panels", Reuters, 2012, <https://www.reuters.com/article/us-usa-china-solar-idUSBRE8991NR20121010>, (Accessed August 17, 2023)

³⁰⁰ HOUDE, Sebastien, WANG, Wenjun, "The Incidence of the U.S.-China Solar Trade War", *Economics Working Paper Series*, No. 22/372, ETH Zurich, CER-ETH – Center of Economic Research, Zurich, 2022. <https://doi.org/10.3929/ethz-b-000543961>. P.9

³⁰¹ CARDWELL, Diane, "U.S. Imposes Steep Tariffs on Chinese Solar Panels", The New York Times, 2014, <https://www.nytimes.com/2014/12/17/business/energy-environment/-us-imposes-steep-tariffs-on-chinese-solar-panels.html>, (Accessed August 17, 2023)

³⁰² DARBY, Marta, *U.S.-China Solar Trade War: Economic and Political Implications of the 2012 and 2014 Antidumping Disputes*, Duke University, 2014, p.10

³⁰³ "U.S. Charges Five Chinese Military Hackers For Cyber Espionage Against U.S. Corporations And A Labor Organization For Commercial Advantage", U.S. Department of Justice, 2014, <https://www.justice.gov/opa/pr/us-charges-five-chinese-military-hackers-cyber-espionage-against-us-corporations-and-labor>

³⁰⁴ WANG Jing 王婧, guangfu zhan jiang sunhai mei yuancailiao shengchanshang 光伏战将损害美原材料生产商 (Photovoltaic War will Hurt US Raw Material Producers), *Xinhua caijing*, 2023, <https://www.cnfin.com/world-xh08/a/20130725/1218144.shtml>, (Accessed August 17, 2023)

³⁰⁵ Reuters, "Trump imposes steep tariffs on imported solar panels and washing machines", The Guardian, 2018, <https://www.theguardian.com/environment/2018/jan/23/trump-imposes-steep-tariffs-on-imported-solar-panels-and-washing-machines>, (Accessed August 17, 2023)

raised the tariff to 18% in 2021. This led more than an American company and non to open their factories locally, as prices were increasing for exports. For instance, the Chinese Jinko Solar opened a factory in Florida to avoid tariffs. Subsequently, China asked the WTO for consultation with the United States. In fact, the Chinese government was accusing its counterpart to have violated international trade rules.³⁰⁶ However, the United States won the case, as the Panel rejected all claims coming from China.

In 2019 another set of tariffs was imposed to Chinese solar exporters. Section 301 imposed a 25% tariff on Chinese solar cells, modules, and components such as solar glass, back sheets etc.

The now President Joe Biden assumed office in 2021 and soon was called to extend tariffs on Chinese solar products. In fact, its government ordered a ban of materials from Hoshine Silicon Industry accusing the company of forced labour in Xinjiang. It was not the only company working on the solar sector that has been affected by these accusations and bans, this because Xinjiang production of polysilicon solar modules accounts for a big part of the global production.³⁰⁷

In March 2022, an investigation began over the fact that China could have moved its manufacture in Cambodia, Malaysia, Thailand and Vietnam. Recently, five Chinese companies were found guilty, but no duties are programmed to be imposed, as President Joe Biden stopped tariffs on solar panels for two-years in 2022 because of the fear that these duties may actually damage the America production, so we eventually will see them imposed in 2024.³⁰⁸ Even if China is not the biggest exporter in the US, it is reported to grow its volumes because of the stop of these tariffs.

As in Europe, not everyone was in favour of tariffs. A study revealed in 2019 by the Solar Energy Industries Association (SEIA) showed that more than 62,000 jobs were lost in the US, together with a \$19billion loss on private investment.³⁰⁹ The report also registered a decreasing of capacity that turned out to be negative from 2017, with a capacity decrease accounting for almost -2.500MW in 2017 and around -3.500MW in 2021.³¹⁰ The Section 201 tariff was also now as effective as it should have been. In fact, because the duty was not applied for the first 2.5GW imported, for the first three years of its implementation almost every import was exempted from the tariff, because

³⁰⁶ FANG, Mandy Meng, "A crisis or an opportunity? The trade war between the US and China in the Solar PV Sector", *Journal of World Trade*, vol. 54, no. 1, 2020. <https://dx.doi.org/10.2139/ssrn.3441479>. P.4

³⁰⁷ MARTINA, Michael, FREIFELD, Karen, SHEPARDSON, David, "U.S. bans imports of solar panel material from Chinese company", Reuters, 2021, <https://www.reuters.com/business/us-restricts-exports-5-chinese-firms-over-rights-violations-2021-06-23/>, (Accessed August 18, 2023)

³⁰⁸ NILSEN, Ella, "Feds determine five Chinese solar panel companies have been skirting US tariffs", CNN, 2023, <https://edition.cnn.com/2023/08/18/politics/solar-investigation-commerce-china-climate/index.html>, (Accessed August 18, 2023)

³⁰⁹ SEIA, "Study: Solar Tariffs Cause Devastating Harm to U.S. Market, Economy and Jobs", SEIA, 2019, <https://www.seia.org/news/solar-tariff-impacts#:~:text=Solar%20tariffs%20are%20costing%20the,%249.5%20million%20of%20lost%20investment.>

³¹⁰ Ibid.

the limit has not been reached.³¹¹ Some argued also that these duties could slow down Biden administration's green targets such as the elimination of fossil fuels as an energy source by 2035 and the substitution of it with renewable energy sources, giving emphasis to solar power. A research published from SEIA demonstrate that in order to meet its climate target, yearly solar installations must increase by 60% above current forecasts between 2022 and 2030³¹², so we can easily conclude that tariffs over imported solar goods and materials will pose an important challenge to the realisation of these climate goals. Another report showed that between 2018 and 2020, American final consumers paid \$1.3billion more for their solar products because of Section 201 tariffs.³¹³

3.2.6 HOW DID THE TWO DISPUTES DIFFER?

By a simple analysis, we can conclude that the main motive that guided the two disputes was the same: Chinese companies are dumping solar PV prices through favourable policies developed and implemented by the government, damaging local manufacturers. However, how the two disputes ended, how confrontations between institutions were made, and how the thought about green targets affected them differ a little bit.

Both disputes were raised on the same period, between 2011 and 2012, when China was starting to fulfil the targets set on the Twelfth Five-year Plan, where the solar sector was one of the Strategic Emerging Industries and the country became one of the biggest investors on renewable energies. However, at the same time, China was facing an oversupply crisis and several companies were declaring bankruptcy, for instance, the Chinese solar pioneer SunTech declared bankruptcy in 2013. This happened because of different European countries' cut on installation subsidies that generated a decline of solar PV demand and a subsequent overcapacity and a decline of prices on the sector. We have seen how the Chinese government stimulated the internal market after these external shocks, and it eventually led the sector to be dominant again. Because of this, many against duties on imported solar PV from China argued that instead of imposing barriers on trade, we should all collaborate to build an integrated and complete solar PV production and fight climate change, also

³¹¹ FELDMAN, David J., "To understand why Biden extended tariffs on solar panels, take a closer look at their historical impact", The Conversation, 2022, <https://theconversation.com/to-understand-why-biden-extended-tariffs-on-solar-panels-take-a-closer-look-at-their-historical-impact-177528>, (Accessed August 18, 2023)

³¹² SEIA, "30% by 2030: A New Target for the Solar+ Decade", September 2021, <https://www.seia.org/research-resources/30-2030-new-target-solar-decade>.

³¹³ LEE, Tom, "Solar Tariffs and President Biden's Climate Agenda", American Action Forum, 2022, <https://www.americanactionforum.org/insight/solar-tariffs-and-president-bidens-climate-agenda/>, (Accessed August 19, 2023)

in order to increase employment.³¹⁴ In fact, in the European case, this particular factor was highly discussed. At the beginning of the dispute, different European institutions and companies believed that duties were to imposed to eliminate competition and fight dumping prices. But after years of discussions and consultations, the general idea was that Europe, as the largest consumer of solar energy, should take advantage of China's competitive advantage and reach the climate targets also through the market access of European technologies.³¹⁵ When the European Commission announced the end of tariffs against solar products imported from China, the 27% of renewable energy consumption target to be met by 2030 was mentioned, signalling the willingness to collaborate with China on the fight against climate change.

On the other hand, the American view over the dispute seemed to be a bit different. Some institutions viewed these trade barriers as part of the US-China competition, and so they were in favour of them because they could damage China's growth, influence and catching-up.³¹⁶ The US is the second largest consumer of fossil fuels, so the country should give importance and relevance to its climate targets also for the good of the rest of the world. However, we have seen also through the withdraw from the Paris Agreement, that the Trump administration was not that interested on the fight against climate change. In conclusion, we can suppose that until 2021, solar tariffs against China were more political than other. In 2022, the Biden administration stopped these duties because of the fear that demand could not be satisfied. Politicians in favour of solar tariffs claimed that the current administration is giving more importance to the Chinese government and American corporations instead of helping American workers. They believe that by sanctioning China and gradually moving the manufacturing in the States would create more jobs. The fact is that in order to completely substitute imports with local production takes a lot of time and resources that are now partially given by the IRA policy.³¹⁷

So basically differences on disputes over Chinese monopoly on the solar PV sector is influenced also by political relations, as we have seen. We add here that different European countries are also collaborating with China through the Belt and Road Initiative (BRI), a project released in 2013 and central for President Xi Jinping's foreign policy that aims at a bigger economic collaboration and development of infrastructure globally. Specifically, the Green Belt and Road has the reduction of climate emissions as a target, while also increasing economic opportunities. The project was released after the European solar dispute, but the fact that the US has never showed interest in the

³¹⁴ WWF International, Dutch environmental group Natuur & Milieu, E3G, Change Partnership, *Position paper on the proposed punitive import tariffs on Chinese solar panels*, May 2013.

³¹⁵ GORON, "Fighting against climate change", p.122

³¹⁶ EVENETT, Simon, FRITZ, Johannes, "Brazen Unilateralism: The US-China Tariff War in Perspective. The 23rd GTA Report.", *Centre for Economic Policy Research*, London, 2018. P.8

³¹⁷ WESOFF, Eric, "The threat of new US solar tariffs is back", Canary Media, 2023, <https://www.canarymedia.com/articles/solar/the-threat-of-new-us-solar-tariffs-is-back>, (Accessed August 19, 2023)

initiative, also when it started to include green targets, confirmed that politic and economic factors were more important than the green one.

3.2.7 THE FUTURE OF THE PHOTOVOLTAIC SECTOR

As we have seen, the solar PV sector and the solar power generated by it are central for the green transition, together with wind energy. Through the years, photovoltaic technologies had a fast development, with constant price reductions and increase of installations. In 2019, the International Renewable Energy Agency (IRENA) reported that by 2030 solar cumulative capacity could reach 2840GW, and 8519GW by 2050 globally.³¹⁸

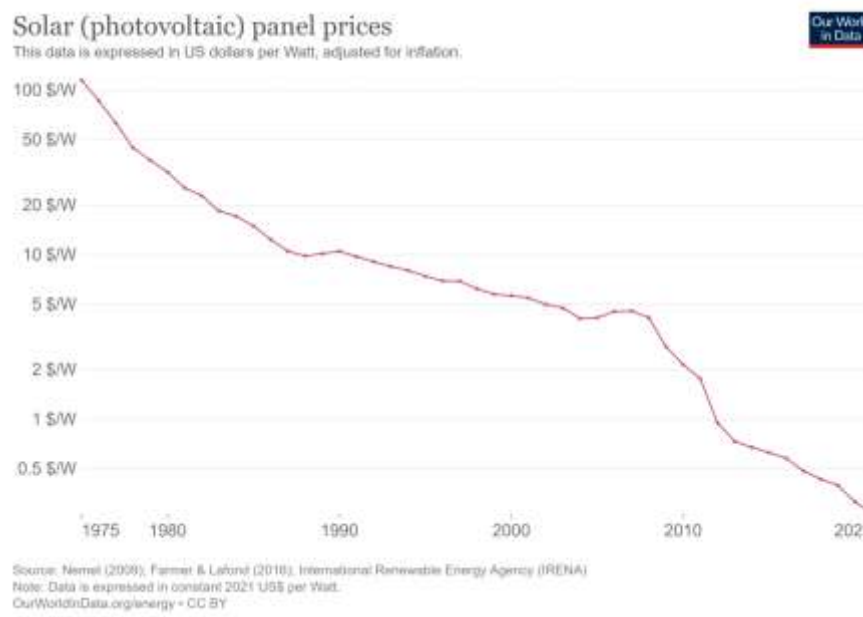


Figure 13 source: Our World In Data³¹⁹

This graph shows how solar panel prices dropped during the years until 2021. It is mesmerising how fast the reduction went, and if we look closely we notice that in 2011, when China started to face solar disputes with Western countries, the price was 1.77\$/W, in 2012 it was 0.95\$/W and in 2013 0.73\$/W. The price trend let us believe that prices will continue to drop and they are not that dependent on tariffs against Chinese photovoltaics imports. A research conducted by Helveston, He and Davidson (2022) showed that if Germany, the US and China applied nationalistic policies

³¹⁸ IRENA, *Future of Solar Photovoltaic: Deployment, investment, technology, grid integration and socio-economic aspects* (A Global Energy Transformation: paper), Abu Dhabi, International Renewable Energy Agency, 2019. p.21

³¹⁹ "Solar (photovoltaic) panel prices", Statista, <https://ourworldindata.org/grapher/solar-pv-prices>

through the years but installing at the same rate, PV module prices would have been much higher than the actual prices, in particular 54% higher in China, 107% in the US and 83% in Germany.³²⁰ As it is impossible for Western countries to completely decouple from Chinese production, at least on the short term, we can conclude that price will not increase, as it is inconvenient to keep imposing tariffs on a key sector such as the solar PV one.

As far as supply chain is concerned, cost competitiveness is still relevant and poses a challenge on the diversification of supply chains. In 2022, IEA reported that costs in India are 10% higher, 20% higher in the US and 35% higher in Europe if compared with China.³²¹ But China dominates the industry also because of another advantage: critical minerals and materials. Critical minerals and materials were defined by the Energy Act of 2020, they are essential components of many clear energy resources, solar panels included. Their demand is continuously rising due to green policies and incentives around the world that stimulate green resources. China detains 60% of rare earth elements, and some of them are necessary for the production of solar PVs. For instance, China was the biggest producer of aluminium, accounting for 40million MT in 2022. The US produced 860.000 MT on the same year.

Even when talking about manufacturing capacity, China plays a dominant role worldwide.

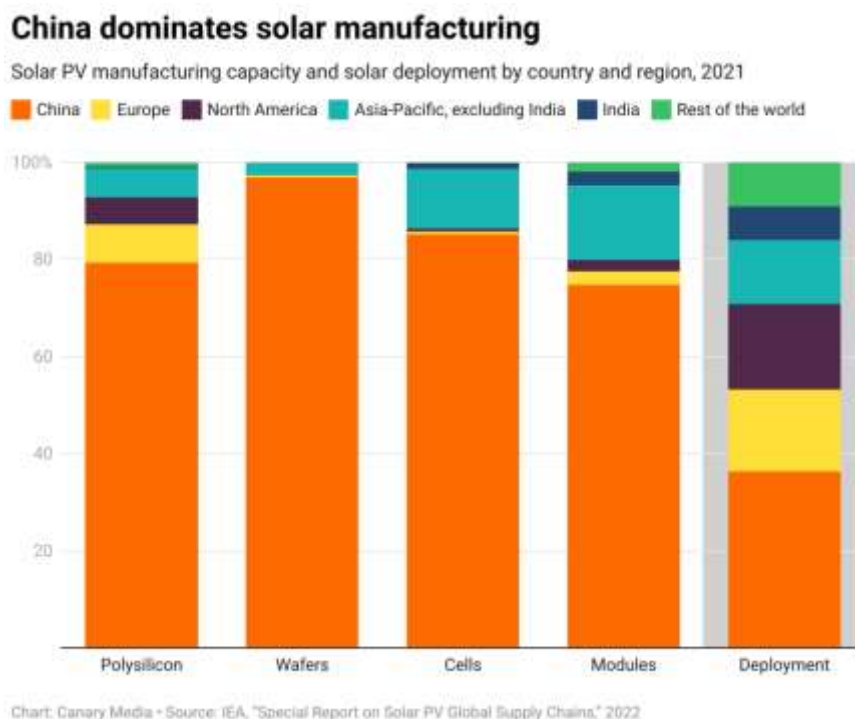


Figure 14 source: IEA

³²⁰ HELVESTON, John Paul, HE, Gang, DAVIDSON, Michael R., "Quantifying the cost savings of global solar photovoltaic supply chains", *Nature*, vol. 612, 2022, pp. 83-87. <https://doi.org/10.1038/s41586-022-05316-6>. p.84

³²¹ IEA, *Solar PV Global Supply Chains, An IEA Special Report*, July 2022. <https://iea.blob.core.windows.net/assets/d2ee601d-6b1a-4cd2-a0e8-db02dc64332c/SpecialReportonSolarPVGlobalSupplyChains.pdf>

In 2021, every step of the manufacturing of solar PVs was mainly dominated by China, just the manufacturing of wafers accounted for 97%. We notice here how little is the European and the American slice, letting us affirm that the complete independence from China's solar manufacturing would require more than a couple of years. Polysilicon manufacturing was 79% in China, only 8% in Europe and a little 6% in North America. In 2013, China produced 36% of total polysilicon worldwide, and it was already the biggest producer. Forecasts show that polysilicon production is expected to grow in Asia-Pacific regions because of some favourable policies, but China will keep its dominant place.³²² Same trend is reported for wafers production.

The fact that solar power is still a key element on the Chinese economy let us believe that the country will be extremely relevant on photovoltaics global supply chain. China is still investing a lot on R&D, as we have understood through the Five-year Programmes launched by the government. In spite of the fact that China is giving much more attention to the domestic demand, rather than the export of solar PV components, the country is still dominant worldwide. Countries that have important green targets such as the United States and the European Union, should recognise the impact that industrial policies had on China and start to develop a strategy that could work on the domestic situation, implementing not only policies aiming at the demand side, but also at the supply side, where the disputes have made clear that there is both a lack of collaboration between green industries and a lack of domestic production that caused to be too dependent on foreign supplies. In fact, the European Green Deal and the American IRA could be seen as important sets of policies that could boost both the European and the American domestic production. These projects both take solar PVs as important tools where investments should be made, and where local companies should be supported to be more competitive on the global market.³²³³²⁴

³²² "Polysilicon Market Size & Share Analysis – Growth Trends & Forecasts (2023-2028)", Mordor Intelligence, <https://www.mordorintelligence.com/industry-reports/polysilicon-market>, (Accessed August 22, 2023)

³²³ KOUGIAS, Ioannis, TAYLOR, Nigel, KAKOULAKI, Georgia, JAGER-WALDAU, Arnulf, "The role of photovoltaics for the European Green Deal and the recovery plan.", *Renewable and Sustainable Energy Reviews*, vol. 144, 2021. <https://doi.org/10.1016/j.rser.2021.111017>.

³²⁴ WEAVER, John Fitzgerald, "What's in the Inflation Reduction Act for the solar industry?", *PV magazine*, 2022, <https://www.pv-magazine.com/2022/08/15/whats-in-the-inflation-reduction-act-for-the-solar-industry/>, (Accessed August 22, 2023)

3.3 CONCLUSION

Through an analysis of major state interventions in China, we have understood how important it was the role of the government on the development of the manufacturing industry. Since the opening-up policy largely promoted by Deng Xiaoping, China has completely changed, and subsequently, every country of the world has changed their perception of it. Industrial policy played a central role on this economic change, from the transition period, to becoming the world's second largest economy. China's development through these policies has been taken as an example from other developing countries, rising again the question whether industrial policy should be implemented or not. However, we have seen that since the 2008 financial crisis, the debate is not if it is fundamental or not, but how it should be applied. The change of perspective of industrial policy reached also Western countries that have long refused the use of industrial policies. The European Commission presented in March 2023 a plan to build and give subsidies to the zero-emission European manufacturing industry, in order to be competitive in its technologies concerning clean and renewable resources.

Going back to China, it used its comparative advantage of cheap labour costs to build an industry that could produce a lot, and export a lot. This advantage was also used on the green industry. In fact, China was able to build a solar industry using different policies that increased technologies and production on the sector. This phenomenon was not casual, as the country planned its economy and subsequent targets every five years through the Five-year Plans were clearly presented to economic actors. Thanks to a precedent planning of resource allocation and policies, China was able to organise its economy, with a clear and defined plan. The SEI definition and the MIC 2025 plan were fundamental for the realisation of the development of different sectors where China is now the leader, for instance IT and energy-saving environmental protection. MIC 2025 has the innovation and digitalisation of China as target. Xi Jinping's goal is to change the world's perspective on China, from "the world's industry" to a technological centre.

The rapid industrialisation of China and the enormous production located in the country, led China to become one of the world's largest polluters. However, the green concept has been gradually present on Chinese programs and policies, setting also important targets such as carbon neutrality by 2060. Huge investments have been made in order to foster the green transition and build a more sustainable manufacturing industry. China is also committed to collaborations in order to fight climate change. We have understood that, although the European fears a too high dependence and

an unfair competition with China, the two institutions are working hard to build a sustainable environment also when talking about manufacturing and trade. Relations with the US are known to be tricky, and this is noticeable also when talking about the environment and sustainability. There are some specific sectors where not only Western countries are concerned about unfair competition with China. In particular, the solar PV industry has been particularly discussed by foreign institutions because of Chinese “dumping prices” policies. In fact, the biggest concern was that Chinese solar products were much cheaper than Western ones. The solar PV sector was recognised by the Chinese government as one of the SEI where subsidies should be allocated. This led to different projects and policies aimed to boost this sector, such as the Golden Sun Project. In 2011, China was dominating the industry worldwide thanks to its huge exports at cheap prices. Disputes were raised both in the European Union and the United States, but results differ. The dispute with the European Union ended up with a price limit and the gradual elimination of tariffs. On the other hand, the US government went far with tariffs, moving its supply to other countries. We noticed that Europe gave priority to the green problem: how can Europe meet its environmental goals without the supply of solar PV components from China? The US had a more economic approach, focusing more on job and local production problems.

In a globalised world as we are now, it is almost impossible to go back to protectionism measures. Not only concerning the solar industry, but also other sectors are dependent on foreign technologies, supplies and R&D. The green transition and the battle against climate change are common goals that should become priority to every new policy and collaboration pacts between countries. Political and economic factors that undermine these goals should not be accepted. At the same time, a fair competition on the global market is precious for the development of new companies, as it boosts research on new technologies to compete on it. The resolution of the solar PV dispute of the European Commission is an example of limiting the monopoly of a country while, at the same time, keeping active the global supply chain. The European Union, as the US, cannot meet its environmental goals without the Chinese supply, at least by now. The European solar manufacturing is still too little to satisfy every state member. Both the EU and the US should invest and increment policies aimed at the facilitation at the industrial level, and not only at the consumption level.

In conclusion, China has been successfully implementing industrial policy, and the solar PV industry is a great example of its relationship with competition. Hopefully, this particularly important sector will become an industry where different new technologies and development can be shared worldwide with the sole scope of the improvement of the environment.

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