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China's new development path: what is driving China to invest in renewables?

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ABSTRACT

应对气候变化是最近几年讨论的最有争议的主题之一。世界上的每个人都认识到威胁，迟早会无可挽回的破坏我们的行星的存在，但仍然采用的手段争取环境保护的结果是不够的。

从工业革命开始，全球气温从未停止上升，对整个生态系统造成灾难性后果。保持工业生产的同一比率，甚至在今后提高产量，将使我们面临不可持续的损害，并将影响到每个人的正常生活进程。

许多环境组织的诞生证明了社会各界对遏制气候变化问题的坚定承诺。他们提高认识的项目促使人们更加自觉地使用资产和自然资源，同时努力阻止人们支持污染活动，特别是那些来自特定行业的污染活动。

最近，社会需要更强有力的参与，使人们注意到政府机构在环境保护框架中的存在不足。为了帮助实现与减缓气候变化有关的目标，来自上级的支持是根本的。教育过程的目的是提高认识不能追求没有通过国家实施适当的组织计划. 另外管行政的机构应设置为主要目的完全符合可持续发展的概念，社会的发展，保证财富的增加和对环境的尊重之间的平衡。

如前所说，污染的很大一部分是工业造成的，特别是那些使用化石燃料燃烧的传统生产系统的工业。由于煤炭、天然气和石油等物质的燃烧所造成的大量碳排放，尤其是二氧化碳的形式，是造成臭氧层空洞和全球变暖的首要原因。为了满足日益增长的商品和服务需求，工业界加大了生产节奏，从而导致了温室气体排放量的增加。

密集型生产工业是各国迅速发展经济的结果，因为他们愿意在国际市场上确立自己的领袖地位。为了追求经济增长和获取更多的权力，发展中国家比其他国家更有效地推动工业对资产的最大利用。

在发展中国家中，中国已经结束了第二次世界大战以来，参与社会的不同方面的改造是一项伟大的工程，并已向一个迅速崛起的经济，对其结构的变化，包括工业部门。因此，国家向国际市场开放，促进了生产，使人们对原材料和能源的需求前所未有。

有趣的是注意到，最新研究环境问题已导致中国采取新的态度，已被翻译成重组其经济模式，更加注重可持续发展和绿色增长。加入全球减缓气候变化方案的项目几乎是为了改善政府的资产，例如行政部门和金融机构，这些机构一直在鼓励采用更严格的法律和绿色金融工具。

通过这种方式，该国的主要重点转向了寻找解决办法来限制工业造成的损害的必要性，这些工业的生产主要是以煤炭为基础的。事实上，中国的能源结构主要依靠煤来消耗能量，使国家在世界上污染最严重的一。为减少碳排放的努力都为一个基于低碳化，是由大量的投资向新能源和绿色技术来源支持的概念体系的创作铺平了道路。

今天，在可再生能源的全球总投资的很大一部分来自于中国，预计将支持他们为3600亿美元到2020。投资计划是巨大的，它的实施必须考虑到不同来源的地理限制和可用性，昂贵的安装，困难的存储过程和能源传输问题的不同问题。

新能源结构的转变将反映在国家发展的各个方面，包括工业生产机制。清洁能源产生的能源与化石燃料相比有不同的成本，电力价格可能因可再生能源的可用性而有所不同，工业可能不得不面对常规工业过程和支出的变化。

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INTRODUCTION

Fighting climate change is one of the most controversial themes discussed during the last years. Everybody in the world recognize the presence of a threat that sooner or later will irremediably damage our planet, but still the mean employed to strive for environmental safeguard result to be insufficient.

From the beginning of the industrial revolution, the global temperature has never ceased its increase causing disastrous consequences over the entire ecosystem. Clearly, keeping the same rates of the industrial production or even raise them in the future will lead us to face unsustainable damages and it will affect the normal life course of each person.

The birth of many environmental organizations evidences a strong commitment from an always wider part of the society to contain the climate change related problems. Their awareness raising projects have given rise to the actualization of a more conscious use of assets and natural resources, and at the same time, have worked to discourage people to support polluting activities, in particular the ones coming from specific industries.

Recently, the need for a stronger involvement from society has shifted the attention towards the inadequate presence of governments' institutions in the framework of environmental care. In order to help achieving the objectives related to climate change mitigation, the support from the higher authorities is fundamental. The educational process aimed to increasing awareness cannot be pursued without a proper organization plan implemented by the state, and institutions should set as their primary objective the development of society in full compliance with the concept of sustainable growth, guaranteeing a balance between wealth increase and respect of the environment.

As mentioned, a great part of responsibility for pollution is addressed to industries, in particular those using conventional production systems structured

on the combustion of fossil fuels. The high quantity of carbon emissions resulted from the burning of materials such as coal, natural gas and oil, in particular in the form of CO_2, are sustained to be the first responsible for the widening of the hole in the ozone layer and the global warming. The need for meeting the increasing demand of goods and services has led industries to intensify their rhythm of production and has consequently caused an increase of greenhouse gas emissions.

Intensive-production industries are the result of the countries' rapid escalation towards a faster economic development given by their will of establishing themselves as leaders in the international market scenario. In order to pursue economic growth and gain more power, developing countries more than others push industries to the maximum exploitation of assets.

Among the developing countries, China has been involved in a great project of renovation of different aspects of the society since the end of the Second World War, and has been directed towards a rapid rise of the economy, working on its structural changes including the industrial sector. The opening of the country to the international market, then, has boosted production, causing the need for consumption of raw materials and energy like never before.

It is interesting to notice that the latest developments concerning environmental issues have led China to adopt a new attitude that has been translated into a reorganization of its economic pattern, more focused on sustainable development and green growth. The project of joining global programmes for climate change mitigation has been drawn near the purpose of improving the government's assets, such as the administrative department and the financial institutions that have been fostering the adoption of stricter laws and green financial tools.

This way, the major focus of the country has shifted towards the need for finding a solution to limit the damages caused by the industries, whose production is mainly based on the use of coal. The structure of China's energy

mix, in fact, mostly relies on the consumption of energy coming from coal, making the country one of the most polluted in the world. The efforts to reduce the carbon emissions have paved the way for the creation of a system based on the concept of low-carbonisation that is supported by massive investments addressed to new sources of energies and green technologies.

Today, a large part of the global total investments in renewables comes from China, which is expected to support them for an amount of USD 360 billion by 2020. The investment plan is huge and its actualization must take into consideration different issues related to sources' geographic limitations and availability, expensive installations, difficult storage processes and energy transmission problems.

The transition to the new energy mix will be reflected on different aspects of the country's development, including the industrial production mechanism. The generation of energy from clean sources has different costs compared to those coming from fossil fuels, the electricity prices may vary depending on the availability of renewables and industries may have to face changes in the regular industrial processes and expenditure.

CHAPTER ONE
AN OVERVIEW ON CHINA'S ROLE IN POLLUTION AND CLIMATE CHANGE

The growing concern of China for renewable energy development has led to the creation of a new pattern for a worldwide discussion. Every year numerous initiatives operating on multiple fronts are supported to face the constant threats of pollution and climate change, issues for which China, together with USA, has been recognized to be the most prevalent responsible.

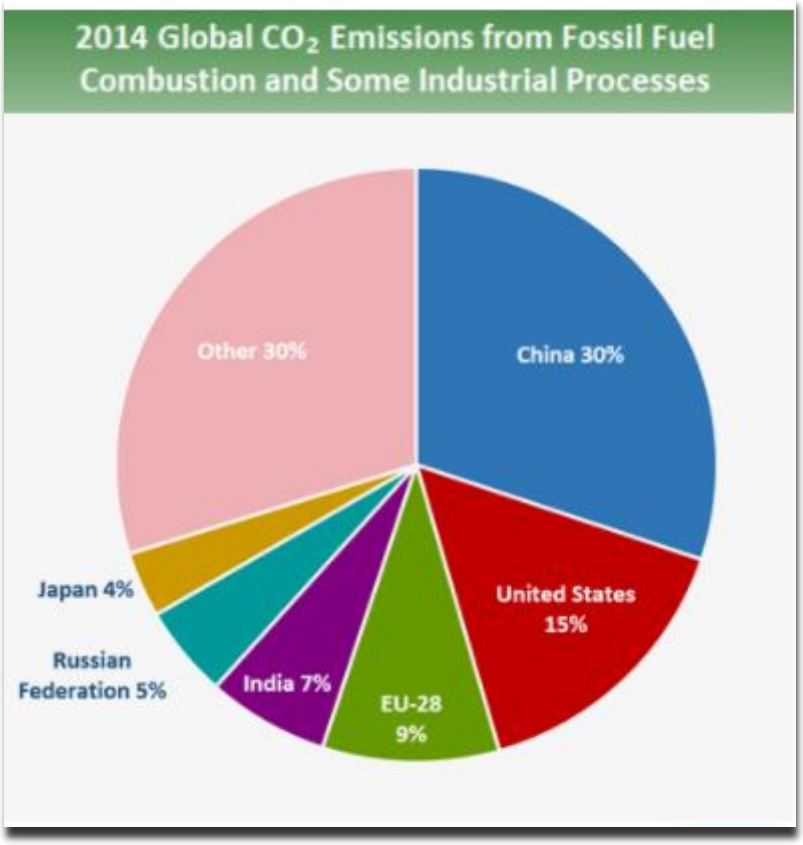

Fig. 1 2014 CO_2 emissions from fossil fuel combustion by country

Source : United States Environmental Protection Agency

During November 2017, the 9th China Renewable Energy Conference & Exhibition (CREC) took place in Jiangsu province. The CREC represents one of the most prominent event of the green sector; it involves the biggest solar power companies and the main actors of the technology industry that are actively participating to the transformation of China into a renewable energy-based country.

If, on one hand, this example shows a further step towards the awareness of the need and the advantage of a concrete solution, on the other hand, it is still difficult to assert when the world will actually witness a real progress. Nowadays, the debate about the causes and the problems generated by pollution still represents a hot topic and the attempts of the Chinese government to find the key that could lead to a turning point is still far from being discovered.

1.1 Coal employment: a social threat and an economic burden

China is one of the largest producer, consumer and exporter of coal in the world. It plays a key role in the global scenario of fossil fuel emissions, since coal consumption accounts about 75% of its primary energy source and three quarters of the electricity generated is coal-fired[1]. According to the International Energy Agency (IEA), 2013 has been the peak year of coal consumption in China; the trend stopped its increase in 2015, when for the first time in 15 years, CO_2 emissions decreased. More recent data, however, show a setback that could determine a new crisis in terms of environmental risks, the previsions of the Carbon Global Project[2] (CGP) for 2017, in fact, indicate that

[1] International Energy Agency (IEA)
[2] The project studies the effects of carbon cycle on environment and human dimension and analyses the causes and remedies to global carbon emissions.

the global trend of carbon dioxide emissions has newly diverted to rise 2%, and the major responsibility is directed towards China. Coal employment still represents a crucial factor for the Chinese rapid economic growth and despite the implementation of new measures to front its dangers, the latter improvements do not state a definitive slowdown. The dependence on coal as main energy source marks the need for more incisive actions in terms of efficiency and emissions control.

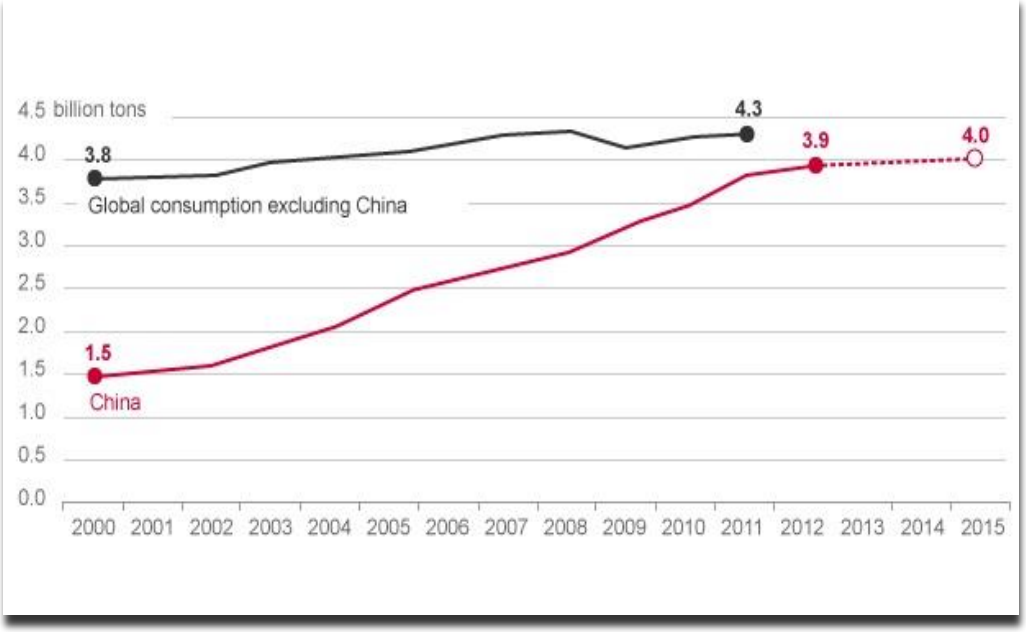

Fig. 2 Coal consumption in China and in the world

Source: U.S. Energy Administration Information, International Energy Statistics

The major challenges that China needs to face can be observed from two main points of view: the impact that carbon dioxide emissions has on the environment and the economic effects that the lack of the employment of coal would arouse. In any case, the burden of the possible outcomes would be reflected on the possible collapse of the world balance, both on social and economic sides. The future prospect makes clear that China is not going to

reduce coal employment; on the contrary, it will continue to be considered the first means for energy production, what is changing is the approach to its use and the recognition of a social problem that affects the destiny of the environment.

1.1.1 CO_2 emissions and social responsibility

Despite many debates around the causes that influence the phenomena called "climate change" or "global warming", the scientific society has recognized the burning of fossil fuels, such as oil and coal, as its primary cause[3]. The greenhouse gases released into the atmosphere, in particular carbon dioxide, are resulting in the increase of global temperature, the rising of the sea levels and the melting of the polar ices.

China first suffers from the effects of the air pollution due the enormous quantity of emissions produced by the coal industries, particularly the ones settled in the main economic centres, where the production is concentred. The government response to the climate change has led to the establishment of the National Coordination Committee on Climate Change (NCCCC), with the aim of organizing the main points of action for climate mitigation including strategies, plans and policies. However, today, big cities as Tianjin, Beijing, Chengdu have average annual PM2.5[4] air pollution concentrations that fail to reach the national standard, and also the cities located on the Eastern side, including Shanghai, are directed towards the same destiny[5]. The national standards in many cities are overcome twice and the international community

[3] Stillman D., Miller D., *What Are Climate and Climate Change?*, https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-climate-change-58.html
[4] PM2.5 stands for fine particulate matter that has a diameter of less than 2.5 micrometers. The exposure to it causes different diseases and premature death.
[5] Greenpeace data 2013

urges the country to take serious provisions to cooperate against a further worsening. Gas and particulate emissions not only can lead to the nitrification of the water, contamination of lakes and forest dieback, but, besides the consequences on the environment, they can also lead citizens to face significant consequences. They are constantly exposed to the dangers brought by air pollution and the inhalation of particulate matter that bring health effects on lungs and heart, resulting in respiratory problems and heart attacks[6]. Statistics of the Global Health Data Exchange of 2016 reveals that more than 4.2 million people in the world died because of the bad quality of air, the majority coming from Asia[7].

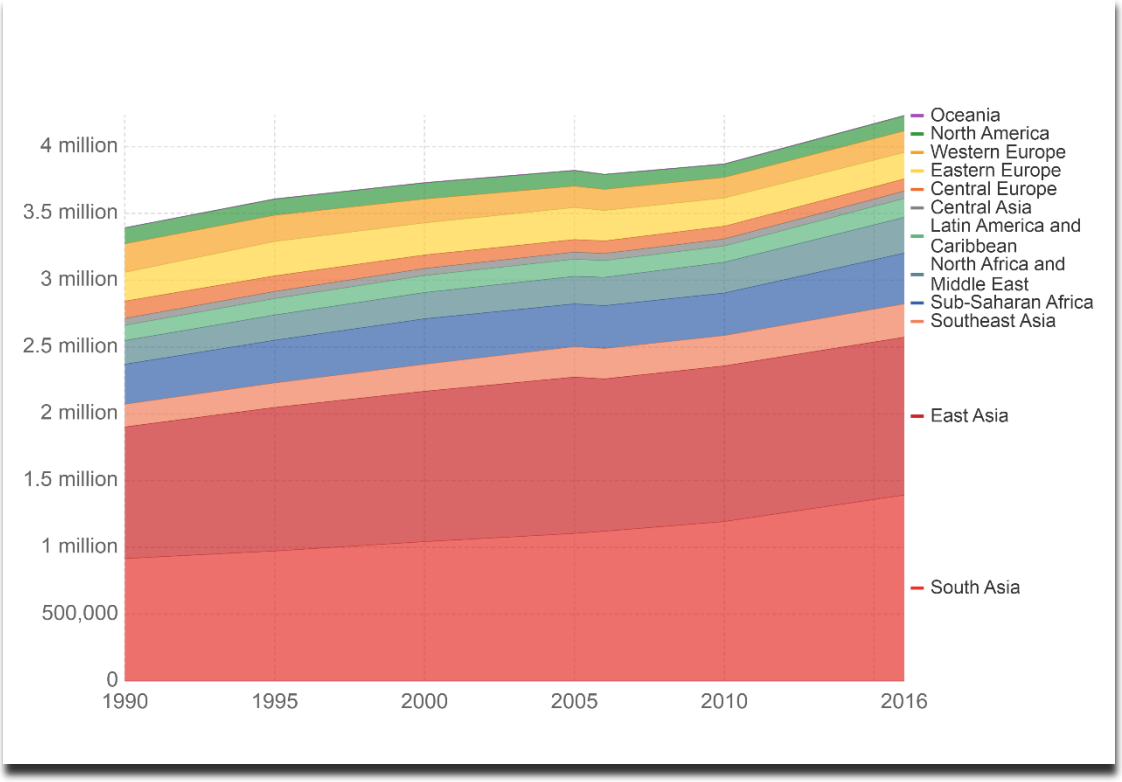

Fig. 3 Annual deaths from air pollution because of particulate matter (PM) and ozone (O_3) by region

Source: Institute of Health Metrics and Evaluation (IHME)

[6] United States Environmental Protection Agency (EPA), *Health and Environmental Effects of Particulate Matter (PM)*, www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm
[7] Ritchie H., Roser M., *Air Pollution*, https://ourworldindata.org/air-pollution

The effects of carbon dioxide could persist for decades also in the hypothetical future when each country responsible for its excessive use would have respected the limits imposed. The damages cannot be easily contained and the world will fight against warming for the years to come; this is why there is the necessity of an immediate energy revolution.

Today, China's commitment to the "green cause" is showed, on the one hand, through massive investments in the market of clean energy, such as solar and wind power, and on the other hand, through the improvement of the already existent technologies of the whole coal chain. The clean coal technology (CCS), for example, would represent an effective way to reduce particulate emissions and waste disposal, replacing old and small power plants working low quality coal with more efficient plants[8]. The larger power plants are provided with control devices that are no longer appropriate due to the enormous quantity of work operated and new methods of energy generation, carbon capture and storage for existing facilities would enhance the conditions of power production. However, the high operating costs and the energy efficiency loss have diverted the attention from it to move towards new researches that can balance expenses and results. The uncertainty of carbon emission prices made the choice of CCS less attractive, and during the last few years, also because of the lack of political and financial dedication, this kind of technology has showed a slow advance.

Workers' safety regulations represent another key point in the reformation framework. Coal mining accidents represent a real issue; data derived by a survey conducted between 2001 and 2008 point out a total of 2,498 injuries and 23,418 deaths for which gas explosions and collapses were associated with the majority of the cases[9]. The decrease of accidents during the

[8] World Nuclear Association, *'Clean Coal' Technologies, Carbon Capture & Sequestration*, www.world-nuclear.org/information-library/energy-and-the-environment/clean-coal-technologies.aspx

[9] Wang M., Zhang T., Xie M., Zhang B., Jia M., *Analysis Of National Coal-mining Accident data In China, 2001–2008*, National Center for Biotechnology Information (NCBI), 2011, www.ncbi.nlm.nih.gov/pmc/articles/PMC3056041/

last years shows a more active participation of Chinese government to the development process. However, if we consider the results starting from the prevention and control of CO_2 emissions to arrive at the improvement of the conditions of workers during the mining process, they still are not up the standards and the current situation still proves to be inadequate to meet the energy demand. The decision to switch to a "green economy" requires a direct action on the economic basis of the country, whose efforts may request decades before the advantages would be tangible.

1.1.2 Evolution of the coal industry and government initiatives

The reasons behind the development of the coal industry must be found in the will of China of becoming one of the greatest economic power of the world. The history has seen China more and more times under the thumb of the western countries, submitted to restrictions and limited to poor action until the Maoist era, when new reforms were implemented. In particular, the reorganization of industry brought to an increasing demand for coal in order to satisfy the needs of production; still today, those measures influence the overall economic performance and force China to face the issues linked to the coal usage.

The first time China experienced the economic benefits brought by small-scale coal industry was during the period of the Great Leap Forward (1958-1963), when people's communes owned them[10]. However, it was only between 1976 -1985, that the purpose of accelerating the economic growth led

[10] The terms people's commune refer to usually rural, communist Chinese social and administrative unit composed from 2000 to 4000 families combined for collective projects.

to the implementation of the 1st Ten-year Plan[11], centred on high savings and investment, strong export orientation and a focus on manufacturing and construction industries. The first previsions of energy consumption were estimated in order to evaluate the need for economic growth, but the assessments for power demand of 2000 resulted wrong, to such extent that the output of coal was a lot higher than the one predicted[12]. The reason of such mistake lies in the presumption that the increase of the gross national product (GNP) would have corresponded to the increase of energy consumption, just like previously observed, when the reforms were not implemented yet[13].

During Deng Xiaoping mandate (1975-1983), different adjustments were made to support reform and opening-up to a market-oriented policy, stating the will to develop large, medium and small coalmines at the same time, and letting the coal price from being centrally planned to be market determined. However, while the private sector saw a new stage of growth, the state-owned enterprises, such as banking and petroleum, keep on covering a central role in the Chinese economy that was regulated according to the principles of to the so-called Socialism with Chinese characteristics.

After the world financial crisis of 2008, a new plan of investments in infrastructures and production capacity, aimed to cope with the difficulties brought by the poor economic activity, gave rise to an additional increase of the consumption of coal, from 3 billion tonnes to 4.2 billion tonnes in 2013[14]. As previously mentioned, the situation still remains critical; the high-energy demand requests precise plans, but the scale of reduction of energy intensity per

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[11] It is a national economic development plan that includes the 5th Five Year Plan (1976-1980). The 1st Five Year Plan (1953-1957) saw its birth under the leadership of Mao Ze Dong and since then the Chinese government continued to operate according to quinquennial plans.

[12] Shen L., Andrews-Speed P., *Economic analysis of reform policies for small coal mines in China*, Resources Policy 27 (2001) 247–254, Elsevier, 2002, p.250

[13] *Ibidem*

[14] Jakóbowski J., *Green economy or coal 'counter-revolution'? Challenges to China's economic reform process, 2016,* www.osw.waw.pl/en/publikacje/osw-commentary/2016-07-27/green-economy-or-coal-counter-revolution-challenges-to-chinas

unit of gross domestic product (GDP) is continuously revised due the uncertainty caused by the lack of a well-structured management chain on different levels. An additional challenge, in fact, lies in the political structure of China: the conflicts of interest between the central government and the local governments do not make easy to carry out and implement adequate policies. Bureaucracy is weak and underfunded; China's State Environmental Protection Administration (SEPA) has only 300 full time staff, while USA counts over 6000[15]. Corruption at all levels is a considerable burden and the failure of implementing effective regulatory and enforcement regimes riles in the small involvement of Beijing in the problems affecting the regional areas. The budget intended for environmental protection is about 1.5% GDP annually, while specialists estimates the need to invest at least 2% GDP to keep a sufficient level of safety[16].

In March 2016, China's 13th Five Year Plan was released and will cover the period up to 2020. The headline targets are to reduce energy intensity by 15% and carbon intensity by 18% compared to 2015 levels. In addition, energy consumption will be capped at 5 billion tons of coal equivalent, and the share of primary energy consumption from non-renewable sources will increase to 15%. The increased carbon intensity goal means that China would reach, or potentially exceed, its Copenhagen pledge to reduce carbon intensity 40-45% below 2005 levels[17]. Actually, the provisions showed an optimistic outcome hard to reach by 2020 and for this reason the targets were readjusted to be possibly reached by 2030.

[15] Economy E, *China's Environmental Challenge: Political, Social and Economic Implications,* 2003, www.cfr.org/report/chinas-environmental-challenge-political-social-and-economic-implications
[16] *Ibidem*
[17] Under the 2009 Copenhagen Accord, China pledged to reduce its emissions intensity by 40-45% from 2005 levels by 2020.

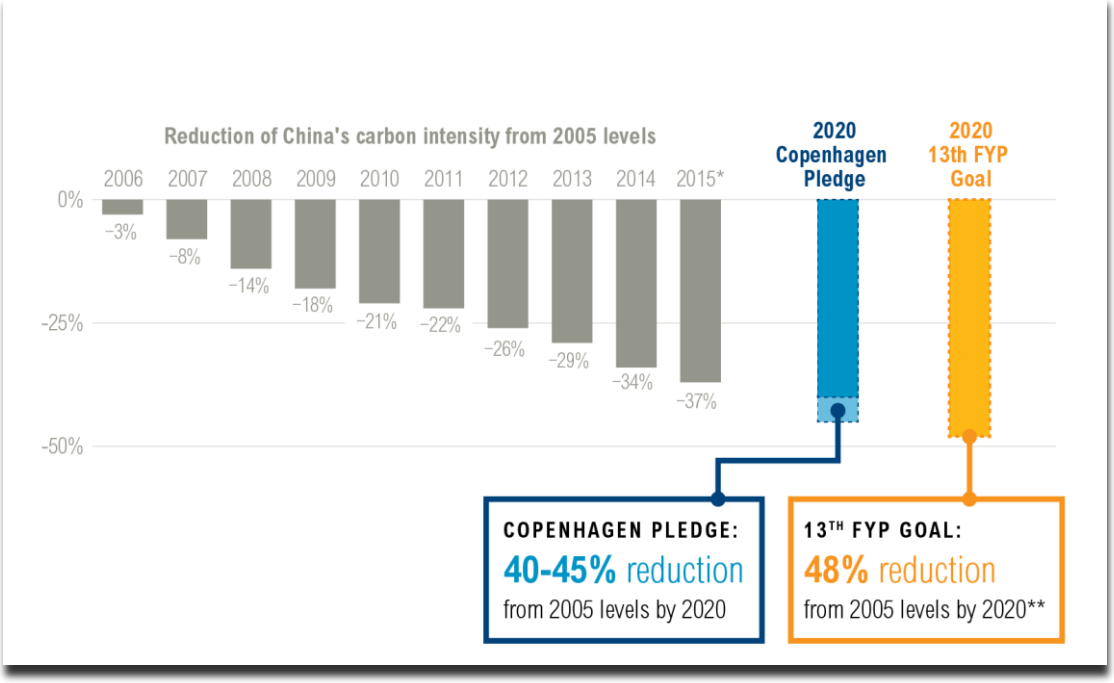

Fig. 4 13th Five Year Plan's carbon intensity target

Source : World Resource Institute

1.2 Towards the adoption of new policies

As previously mentioned, the new era of evolution cannot see its beginning without a proper plan of action. The discussed topic draws the attention to the need of penetrating deeply in what China is concretely actualizing in order to assure a change of behaviour. The main question to meditate on is whether China is actually working to make changes to its rooted structure to cooperate for a global project or the tools adopted are merely directed to maximize its own profits. Moreover, a further aspect to reflect on is: when the country will take part to the global climate programmes, will the internal system's discrepancies be able to not waste its efforts?

1.2.1 Environmental governance

Trying to pursue a low-carbon economy implies the realization of a strong control to assess the implementation of low-carbon rules. The complex governing structure of China does not make easy the supervision of the numerous local governments, which are not always willing to align themselves to the central government provisions. The nature of the territory, in fact, brings the need of a decentralized governance system that distributes power among the different areas, but that does not guarantee a clear disclosure of information and makes difficult the enforcement of the rules when required.

The decentralization covers a wide-range of fields, from the fiscal decentralization[18], which gives local authorities greater power over taxing and spending, to the environmental governance, which guarantees flexibility to manage energy consumption without consequences over local area targets. The mentioned issues are linked in some way and contribute to the delineation of the biggest challenge of China in terms of environment care.

Even if Beijing keeps power over the allocation of the resources and the taxation rates, the local governments, in order to increase revenue without being dependent from the decision of the central government, try to attract outside investments and promote their local industries. Fiscal and politic administration is strictly controlled through revenue collection and distribution, and the local budgets and subsidies, which should be distributed homogenously, often are not uniform, letting some regions lack of sufficient resources to foster development. Evaluation system of local performance is GDP-oriented and therefore officials focus the attention on economic growth as a prior interest in order to reach

[18] Through fiscal decentralization, the country tries to balance expenditure and revenue collection between the local and national government. See Van Der Kamp D., Lorentzen P., Mattingly D., *Racing to the bottom or to the top? Decentralization, revenue pressure, and governance reform in China,* World Development Volume 95 (164-176), Elsevier, 2017, p.165

political promotion and monetary profits. For this reason, the authority of central government pushes local areas to gather more independence according to a system of local revenue that eludes transparency and avoids the full disclosure of information. This situation is directly reflected on the environment when local areas ignore the directives of central government to contain the damages of pollution and instead seek for a faster growth pushing on massive production, unconcerned of the consequences.

Nowadays, environmental governance in China is promoted through command-and-control tools such as emission standards, and market-oriented tools such as environmental taxes. The National Development and Reform Commission (NDRC) is a macroeconomic management agency under the State Council specifically created to assure the proper functioning of different aspects, including issues strictly linked to the environment as for instance energy conservation and climate protection. It works according to the promotion and implementation of programmes that relate the state to the market, and the central government to the local ones. Among its initiatives, it is worth mentioning the Ten-Thousand Enterprises Low-Carbon Programme that was established in 2011 and takes into account energy saving targets. On the one hand, it should help the country reaching the targets of energy conservation, and on the other hand, it should work for the development of an efficient management energy system and should encourage investment in R&D for new technologies. The programme, moreover, is issued for both state-owned enterprises (SOEs) owned by the central government and SOEs owned by local governments. Another important programme implemented by the NDRC is the Energy Conservation Target Responsibility System through which the local carbon budgets are determined starting from the national energy intensity

targets[19]. In this case, local governments are encouraged to meet the objectives set by the central government according to a promotion/punishment system.

More and more regulations are established to help growing an eco-friendly system, assuring, at the same time, enterprises' trustworthiness for foreign investors willing to make investments in China. Beijing is calling for transparency, local governments and their companies since 2007 must respect the Regulations on Open Government Information (OGI) that requests the divulgation of different kind of information, from the greenhouse gas emissions and permits to penalties and name of transgressors. Recently, voluntary disclosure by companies also seems to show further progresses, contributing to the country's common plan for the creation of awareness among people and laying the foundations for a trend reversal. Corporate sustainability data have become fundamental in the investment decisions and most of the times are crucial to encourage or discourage new actions.

However, different studies discuss above the actual benefits of the authoritarian stance of the Chinese government in the environmental governance. The particular features of the country require specific efforts for different aspects, and even if the need for regulations cannot be denied, the way they are performed not always lead to the expected results. The interests of the local governments often are in collision with the government initiatives, or even with the fulfilment of already assigned targets. The requested information are frequently manipulated exploiting the gaps of the control system, or taking advantage of some clauses, as the secrecy acts that regulate the state security[20], giving local authorities the opportunity of broad interpretation of what can be defined a "sensitive information". In other cases, information given are not supported by adequate data and are not useful for investment decisions. In this

[19]"The amount of energy used in producing a given level of output or activity. It is measured by the quantity of energy required to perform a particular activity (service), expressed as energy per unit of output or activity measure of service". Cit.: https://energy.gov/

[20] Van Der Kamp D., Lorentzen P., Mattingly D., op. cit., p.167

way, strict pollution regulations, as well as too high energy conservation targets, could represent a limit to the development of small areas already suffering for the shortage of sources and tools needed to improve industry performance and consequently may lead to a slowdown to the final accomplishment of the green project.

1.2.2 Projects for global cooperation

The urgency of the climate change problem has brought China to coordinate a plan of evolution that, as a first step, should consider the involvement of the country in a wider global project, which tasks must be fulfilled by the totality of participants in a mutual collaboration, while, at the same time, should provide the reorganization of the country fundaments.

Among various global agreements dealing with climate issues, the most influential is the United Nations Framework Convention on Climate Change (UNFCCC), an international environmental treaty entered into force in 1994 intended "to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system"[21]. The 197 countries ratifying the Convention share the same aim and must make available all the possible means to help human safety. In this framework, the industrialized countries responsible for climate issues are part of the so-called Annex I and are bounded to respect the provisions regarding the cut of emissions on home ground. Moreover, they must provide loans and technologies intended to help the reduction of climate change and must report

[21] *First steps to a safer future: Introducing The United Nations Framework Convention on Climate Change*, http://unfccc.int/essential_background/convention/items/6036.php

on a regular basis updates of their conditions in terms of strategies and measures adopted.

The first remarkable action of the UNFCCC saw the ratification of the Kyoto Protocol in 1997, entered into force in 2005 and intended to cover the period between 2008 and 2012. During the first commitment, 37 industrialized countries part of the Annex I were called to control greenhouse gas emissions through the enforcement of national laws referring to the 1990 emissions target. The protocol has been structured in order to help countries reaching their goal more easily providing the establishment of a flexible market based on different tools such as the International Emission Trading, the Clean Development Mechanism (CDM) and the Joint Implementation (JI) and it has been extended for a second period commitment to be completed by 2020. China and more than 100 developing countries, among them also figures the United States, was exempted from the treaty and resulted unbounded from the restrictions concerning the emissions.

The second important programme issued by the UNFCCC is the Paris Agreement, entered into force in 2016 and currently counting 172 ratifying parties. Among different requests, the treaty comprises one precise objective: countries must work to prevent the increasing of global temperature below 2 degrees Celsius above pre-industrial levels and should cooperate to report the achievements and efforts through the Nationally Determined Contributions (NDCs). China, once again, endorses the line of action, but still benefits from the provision's exoneration, since it will fully join the programme only by 2030, after reaching the maximum peak of carbon emissions.

Today, the two biggest polluter of the world, China on one side and United States on the other, are encountering problems in reaching a compromise that can lead the two parties to a smooth cooperation. During Obama period, United States declared their will to ratify the Paris Agreement and started to build a solid relationship with Xi Jinping through three climate change-related

agreements. However, the Trump administration and its retreat from the Paris Agreement has brought to the dissolution of the strengthened partnership and has opened a new age of uncertainty.

In order to incentive developing countries to take part to the programme, much more efforts should be made to highlight the advantages of a cooperation. Negotiations should balance duties and gains in a win-win mechanism where the participating parties would enjoy the long-term economic benefits while offering support to the process of climate change mitigation.

CHAPTER TWO
GREEN GROWTH AND SUSTAINABLE DEVELOPMENT

During the last decades, sustainable development has become the major issue of industrialized and developing countries trying to pursue economic benefits while coping with the need for environment safeguard. The achievement of this goal is still a hard challenge, but the contribution of a multitude of actors, from governments to NGO, is leading to a potential success. The starting point for its realization must begin from the right combination of national policy development and international cooperation, increasing awareness and putting forward ethical behaviour before personal lucre.

For this reason, today, the words "green" and "economy" are often combined when speaking of environmental care and economic growth, indicating a new trend towards a more conscious use of assets while seeking for monetary benefits. Despite the concept is achieving resounding success, it still lacks of a proper diffusion. The United Nations Environment Programme (UNEP) offers a definition according to which: "an inclusive green economy is one that improves human well-being and builds social equity while reducing environmental risks and scarcities"[22]. The UNEP launched in 2008 the Green Economy Initiative (GEI) to encourage green investments and cooperation for sustainable development demonstrating how the classic economic and financial models are exposed to the new climate of innovation. However, in order to achieve satisfying results much work still needs to be done, each country needs to recognize a common definition and shared principles of green economy in order to systematically adopt a precise set of objectives and establish same duties, finally aiming to organize a common line of action. The promotion of

[22]www.unenvironment.org

the idea of "green revolution" must be associated to the concrete statement of profits, costs and risks that each country must be ready to take on. This is why low-carbon economy, sustainable economy, green growth, steady-state economy and so on are all parts of the innovation process aimed to change the traditional decision-making system, acting directly on markets, finance and banking through the setting of environment-friendly policies.

In this framework, China's contribution is more concentrated towards the massive financing of green technologies, which, moreover, constitute a great supply for international business, but the realization of a plan intended to renovate its financial institutions seems to be not far behind. The People's Bank of China, Ministry of Finance, NDRC, Ministry of Environmental Protection, the China Banking Regulatory Commission (CBRC), the China Securities Regulatory Commission (CSRC) and the China Insurance Regulatory Commission (CIRC) together approved the "Guidelines for Building a Green Finance System" in 2016, offering an outlook on the mechanism through which carbon forwards, options, leasing, bonds and so on, can be regulated. China recognizes the possibility of reforming its financial structure involving in the process different carbon-based financing tools.

As previously mentioned, the country's main issue is the limitation of the damages due to employment of fossil fuels and for this reason its main efforts are designed to manage carbon emissions. The choice of replacing the use of coal with new technologies could be encouraged not only by the need for cutting of emissions, but also by the onerous costs and disadvantages brought by containment of its damages. On the other side, the employment of coal still represents the best way to keep an economic advantage due to its contained cost and the flexibility of its usage. The main question, once again, focus the attention on the possible gains that are leading China to take control over coal utilization and in order to understand the decisions of the Chinese government, it is useful to have a wider view of the concept of low-carbon economy and the

main characteristics and organization of the carbon market, looking at carbon pricing and its abatement costs.

Today, cap-and-trade system, carbon tax and carbon pricing, subsidies, voluntary agreements, all constitutes climate change mitigation tools that are widely adopted with interesting results. One of the main limits to the setting of more considerable obligations is the fear that they could lead China industries to lose their competitiveness in the international trade panorama.

2.1 What is a low-carbon economy?

The definition of low-carbon economy is almost immediate. The main objective of a country adopting a low-carbon economy is clearly the promotion of socio-economic sustainable development through the cut of carbon usage. What may represent a challenge is the pattern to follow in order to make it effective; the establishment of such system, in fact, modifies with a great impact the already existent one in different ways. Energy saving, consumption cut and emission reduction can be pursued only taking into account several factors, such as environment care over profit, economic efficiency over great exploitation of sources, balance between production and consumption. Trying to achieve this goal at a minimum cost is even harder.

The big challenge of China, as already explained, is represented by the industrial intensive production, which implicates a great exploitation of coal. For this reasons, the potential solution for climate change mitigation must be found in the development of zero-impact technologies. The vast territory and the need for cooperation between provinces do not make the situation easier; each region has its own rate of carbon emissions, therefore the control over them entails different costs, which consequently underline the need for different

development paths[23]. Government policies must regulate the start-up of the low-carbonisation through educational programmes addressed to producers and consumers. Their focus should be on the creation of a new perception of climate change issues as a core value in their way of making business, in order to naturally lead all the actors involved in the value chain to a change of behaviour and a most responsible use of assets.

2.2 Financial tools for climate change mitigation

2.2.1 Cap-and-trade system

The carbon emission trading is a mechanism came into force in 2005 regulated according to the guidelines of the Kyoto Protocol. Its first commitment period has been established between 2008 and 2012, and required the developed countries to reduce greenhouse gas emission by 5% referring to 1990 levels. Today, during the second period commitment that goes from 2013 to 2020, countries must work to achieve the objective of an emission reduction of 18% against 1990 levels.

The structure of the cap-and-trade system, also recognized as Emission Trading System (ETS), is a market-based approach regulated through the setting of an emission cap that participants, represented by industries, are required not to go over, with the final aim of gaining allowances. The allowances, which are either distributed at no cost or sold, guarantee producers the possibility of keeping the same intensity of production, while assuring a

[23] X. Dou, *Low Carbon-Economy Development: China's Pattern and Policy Selection*, Elsevier, 2013, p.1017

control over the total global carbon emissions. According to this system, every metric tonne of carbon dioxide (tCO_2) emitted requires an emission permit and each participant is subjected to emissions accounting and verification rules organized by the accountability systems and trading infrastructures[24].

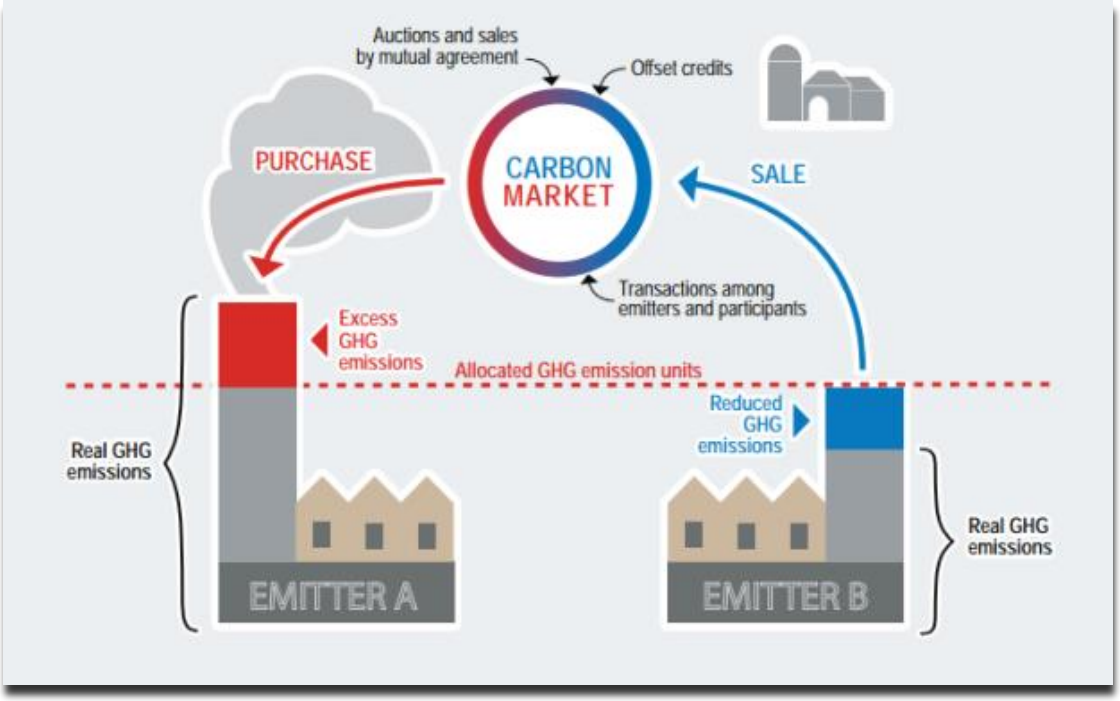

Fig. 5 Cap-and-trade mechanism

Source: Clean Energy Canada

To sum up, the system works exactly like a market where two parts establish deals through purchase and sales of permits and can be explained according to the following scheme:

[24] Guoyi H., M. Olsson, K. Hallding ,D. Lunsford, *China's Carbon Emission Trading: An Overview of Current Development*, Fores, 2012, p.8 and 9

1. If the industry does not use its allowance entirely, it can either keep the remaining allowance for the next commitment period, or it can sell to another polluter;

2. If the industry's emission exceeds the cap before the end of the period, it must buy permits from another industry willing to sell its remaining allowance;

3. Finally, the industry can invest its money to obtain extra permits also in industries whose headquarters are settled in another country.

The trading performance is stated through the measurement of emission reduction (effectiveness), reduction costs (efficiency), green investments and carbon leakage rate[25]. The carbon leakage is an effect usually caused by energy-intensive industries that decide to move their production to countries chosen because of their less restrictive carbon regulations and lower prices, contributing to an increase of dioxide emissions in those territories. This may cause the efforts for climate change mitigation to be useless whereas the main scope of ETS, clearly, is the creation of environmental benefits through the control of the quantity of emissions. In order to avoid such opposite result, the system should provide a way for countries to keep their interests safe through the guarantee of a low carbon price and a low cost of emissions reduction, discouraging strong polluters to move to places where the cost of carbon is more favourable.

As can be read, in order to make it work properly much about the functioning of the mechanism still needs be delineated. Among all, the expectations from participants about carbon pricing constitute a crucial factor, the construction of a well-structured trading platform, a cleaning settlement system and a market supervision system are fundamental. The optimal solution

[25] *Ivi*, p.8

would see the setting of explicit emission targets where the government, on one side, would determine the emission ceiling according to the results of international climate change negotiations, and the companies, on the other side, would be assisted in organizing their strategies to meet their carbon quota at relatively low impact on their business.

2.2.1.1 Development of the carbon market in China

As already mentioned in Chapter One, the Kyoto Protocol regulates the cut of carbon emissions according to three different mechanisms, one of them is the above discussed Emission Trading System. In order to understand the latest developments of ETS in China, it will be useful starting from the description of the effects on environmental policies caused by the adoption of another mechanism issued by the Kyoto Protocol, called Clean Development Mechanism (CDM).

The CDM is a tool that allows industrialized countries to invest in projects of emission containment in developing countries, for example through the installation of solar panels and wind turbines, thanks to which the investors can obtain the Certified Emission Reduction (CER), used or sold when exceeding the carbon cap imposed by the national law. This way, just like with the adoption of the ETS, the global emissions are balanced and the polluters are discouraged to exceed the limitation while supporting green investments and the development of new technologies.

The first efforts to face the threat of climate change have brought China to endorse the CDM in 2004. The adoption of such mechanism obtained a great success, addressing the country to the approach of a kind of market never experienced before. During the years, many developed countries has shown

great interest in investing in projects on the Chinese territory, attracted by the opportunities of developing clean energy production systems. This way, China has become the largest location for CDM projects; in fact, it is possible to notice that at the end of September 2017, 287 CERs projects had been registered, with a total of 118 million tons of carbon emissions traded, while CERs volume is expected to reach more than 70% of the global total by 2020[26].

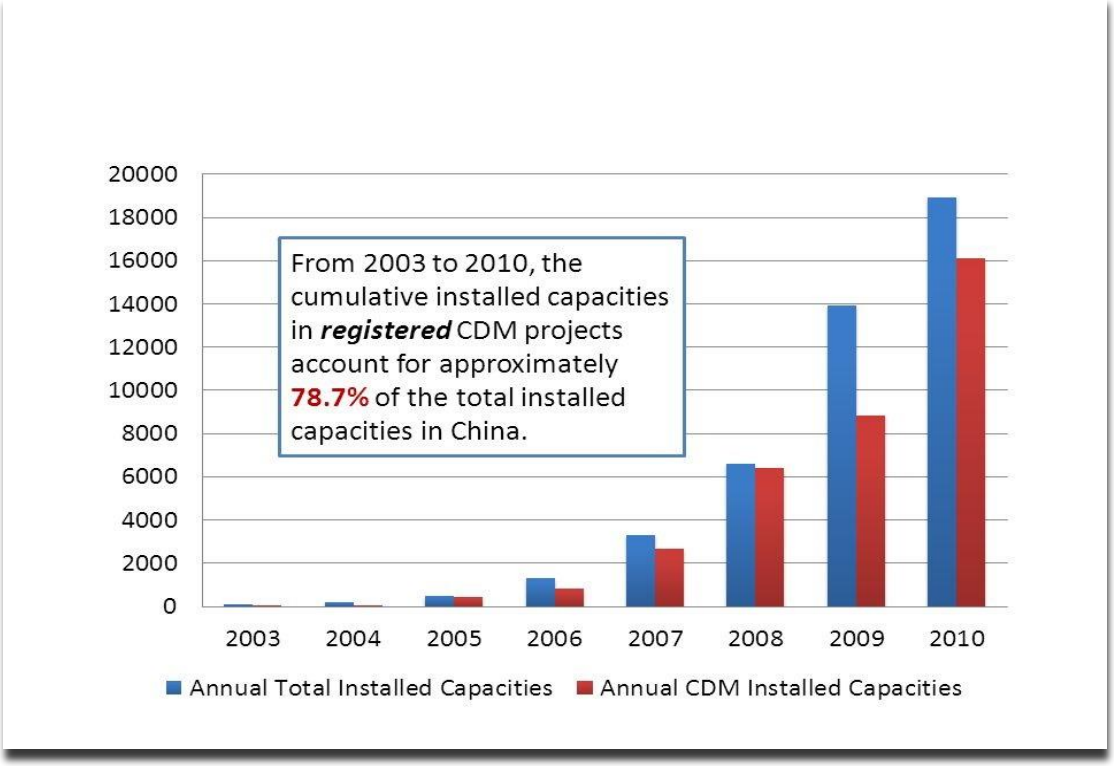

Fig. 6 Wind sector CDM projects in China (unit: MW)

Source: Tang T., Popp D., The Learning Process and Technological Change through International Collaboration: Evidence from China's CDM Wind Projects

[26] De Boer D., Roldao R., Slater H., Qian G., *The 2017 China Carbon Pricing Survey, November 2017*, China Carbon Forum, 2017, p.7

In 2011, the National Reform and Development Commission (NRDC) announced that seven major cities and provinces would have been the spot for the opening of seven market pilots with their respective exchanges to venture to the carbon market for the first time[27]. The results brought by ETS pilots saw the trade of 197 million tons of permits by the end of August 2017, sold at a price of CNY 4.5 billion, that, compared to 2016 values, correspond to an increase of permits of 106% and an increase of price value of 29%[28].

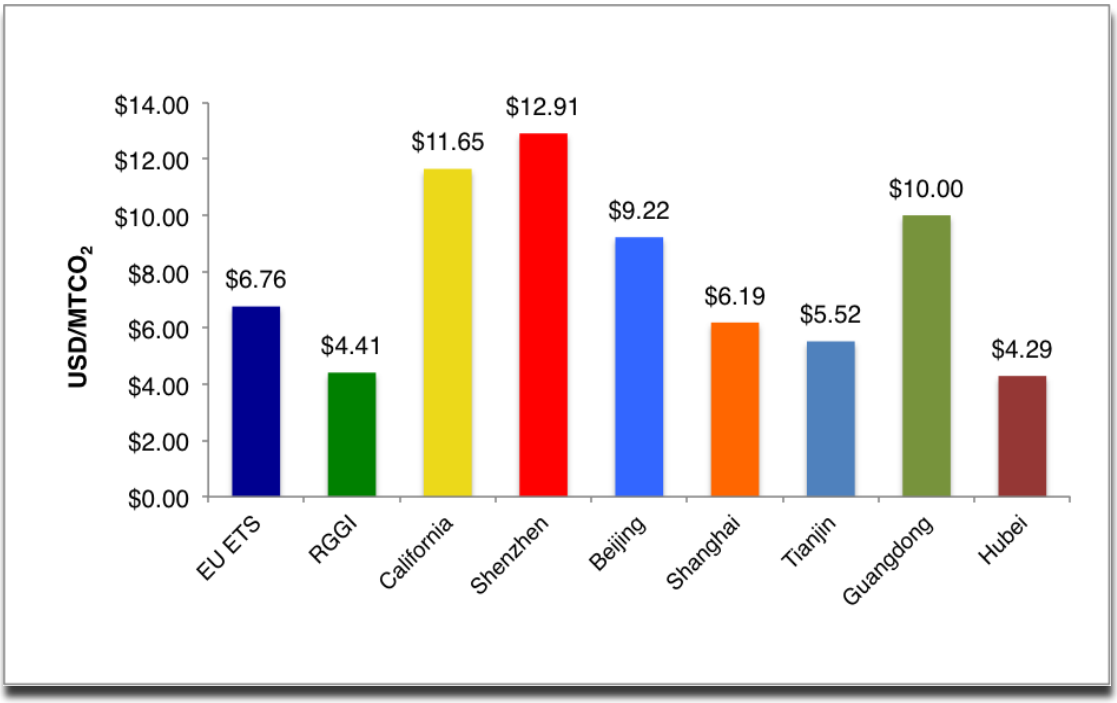

Fig. 7 International carbon market pricing in 2014

Source: Center for Climate and Energy Solutions

Since the Copenhagen climate conference in 2009, the Chinese government increasingly supported research, design and experimentation to

[27] The cities and provinces are: Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei and Shenzhen
[28]De Boer D., Roldao R., Slater H., Qian G, op. cit., p.6

pave the wave for the establishment of its own national carbon market, which has been finally launched in December 2017. Even if the CDM can be considered a good tool for the launching of the carbon trading system in China, there are some points to focus on in order to understand the effects that such mechanism has on the regular economic activity.

First, the majority of the investors come from foreign countries and this means that the internal competition suffer from scarce vitality: few Chinese investors decide to invest in projects to support the low-carbonisation of the country[29]. Actually, the Chinese government has initially showed a less positive attitude towards foreign investors, scared of suffering from the pressure of their "intrusion", and for this reason, has decided to implement different binding policies limiting their actions. For instance, in order to limit the sale of foreign wind turbines on the territory, the government asked that the production of such asset had to be subjected to a local content requirement[30]. The expectation behind such restriction was persuading foreign investors to grant Chinese government the obtainment of technology transfer in form of intellectual property rights.

Second, the uncertainty of the CDM future demand leads China to keep a monitoring position; the development of its own stand-alone domestic trading system is flanked by its will to play a significant role at a global level. Under the rules of global carbon market, there is the belief that in the long period, selling CERs obtained from the implementation of the CDM will be less profitable than participating in international trading of emissions[31].

Finally, it is true that the foreign participants to the CDM can obtain good opportunities to earn CERs through the approval of projects in China, but on

[29] Guoyi H., M. Olsson, K. Hallding ,D. Lunsford, op.cit., p.16
[30] A percentage of goods used in the production processes must be locally manufactured, in the case of China the requirement accounts 70% of the total. (Joanna I. Lewis, *A Review of the Potential International Trade Implications of Key Wind Power Industry Policies in China*, www.citeseerx.ist.psu.edu)
[31] Guoyi H., M. Olsson, K. Hallding ,D. Lunsford, op. cit., p.17

the other side, it does not seem to represent a great solution in terms of reduction of emissions on the territory. In fact, it is estimated that from its beginning in 2004 to 2012, the mechanism caused a global carbon emissions reduction of about 1 billion tonnes of CO_2. If we consider that in 2010 China's emissions were about 9 billion tonnes, this means that the reduction of emissions operated by the CDM projects in eight years on average would balance only one-year China's emissions[32].

The adoption of a carbon trading system can function only under precise conditions and a well developed free-market economy is a key factor. China, still today, cannot be considered being totally in line with international market rules because of the presence of a closed government that aims to keep a strong control over economy, state-owned enterprises, pricing and financial transparency. The establishment of the national ETS reveals the weaknesses of the Chinese government from different point of views, starting from the governance. From the need for straightening the enforcement and compliance systems, the long decision-making process in order to allocate emission permits, the unsuccessful implementation of Measurement Reporting and Verification (MRV) process, to arrive to the control of liquidity, all point out a lack of experience that makes difficult the organization of a working emission trading system.

A further issue threatening the proper functioning of ETS is represented by the strong internal differences between regions that creates problems on various levels and also affect the decision of adopting an absolute or intensity-based carbon cap. In general, the decision about the establishment of a specific cap are dictated by the objectives of a country, and in this case also by the objectives of local governments: adopting an absolute cap can help predicting the future emissions reduction target, but is seen as a limit to economic

[32] *Ibidem*

development because industries must regulate production in order to respect it; an intensity-based cap, instead, is set taking into account the aspects related to the economic activities and the production demand. For a country like China, which bases its development on rapid GDP growth, the second choice seems to be more reasonable, but not all the provinces present the same rate of consumption[33].

With the establishment of the carbon trading system, a series of exchanges have been established too. The government does not nominally control all the exchanges, yet all the exchanges have a strong government banking. The aim of the government support is the creation of a carbon-trading infrastructure able to help the achievement of the national strategy objectives and, as said many times before, leaves behind the purpose of environment safeguard. At the same time however, the exchanges are working to establish registries and standards that could assume an important role in improving the trading system and cooperate for emissions reduction.

Clearly, participating to a project that should help reducing the carbon emissions, but that at the same time, includes opportunities for making profits, creates some concerns among the public opinion. The main fear is represented by the possibility that the industries are given of exploiting the access to permits to keep on fostering polluting activities, cancelling the benefits that the imposition of a carbon cap should guarantee.

[33] Joanna L., *China's Strategic Priorities in International Climate Change Negotiations,* 2007, www.c2es.org

2.2.2 Carbon taxation

The settlement of a carbon tax probably constitutes the only tool able to balance the costs caused by environmental damages due to the industrial production from burning of fossil fuels. This kind of tool can disincentive polluters to keep on producing according to their standard activity because of the imposition of a monetary burden, while encourages them to seek for more profitable opportunities from new types of sources pushing them to the adoption of policies related to energy efficiency[34].

China, after the launch of the ETS, has stated its will to implement a carbon tax contributing to the creation of a more efficient system that is actually able to manage the impact of industrial production on environment by controlling the price of carbon emissions. However, it is still necessary to understand the effectiveness of the carbon tax if associated to different instruments or, to be more exact, if the only implementation of a carbon tax can be sufficient to pursue the government targets. For this purpose, I will refer to a research from Shandong and Jinan University that takes into account the analysis of the combination of different policies in order to discover the ideal mix to achieve national objectives[35].

First of all, the attention of the study focuses on the only implementation of a carbon tax without any other climate policy, reporting the results of the differences of carbon dioxide emission across countries, sectors and energy and, at the same time, indicating the carbon leakage rate and carbon dioxide emission abatement cost[36]. The research shows that the output implications of a carbon tax alone would bring to an alternation of China's economy structure with a

[34]Carbon Tax Center (CTC), *What's a carbon tax?,* www.carbontax.org
[35] Zhang Z., Zhang A., Wang D., Li A., Song H., *How to improve the performance of carbon tax in China?*, Journal of Cleaner Production 142 (1333-4442), 2017, p.2060-2072
[36] *Ivi*, p.2064

shifting of its regular mechanism from the production of industrial goods to the production of non-industrial goods; moreover, the overall industrial output would show a decrease in both China and non-abating countries. The shifting clearly is due to the fact that the production of industrial goods causes high carbon emissions and the presence of a tax would discourage intensive use of coal, leading then to demand reduction and affecting the price of production inputs[37]. On the other side, China's carbon tax would affect domestic trade through the promotion of international competitiveness and would lead to a reduction of the energy price in the international market; the production costs would be reduced when the market supply stays the same and the output growth would be encouraged in non-abating countries[38]. To sum up, China would enjoy the benefits of the emissions reduction, contributing to the decrease of the overall quantity in the world, while non-abating countries would be affected by the consequences of the carbon leakage.

In the second scenario, the paper considers the combination of the carbon tax together with the implementation of other policies. On one side, the integrated tax-tax policy takes into account the revenue recycling while considering the leakage rate and the emission abatement cost, and on the other side, the integrated tax-subsidy policy demonstrates the effects of low-carbon energy subsidy. In the first case, the hypothesis shows that a low capital tax rate would cause the reduction of the carbon leakage rate and would bring a cost-effectiveness improvement. In the second case, it demonstrates how when there is an increase of low-carbon energy subsidy, it is to say those measures aimed to control prices and reduction of costs, there is a decrease of leakage rate and emission abatement cost[39].

[37] *Ivi*, p.2066
[38] *Ivi*, p.2068
[39] *Ivi*, p.2069-2070

After the analysis of the factors that could affect the performance of the carbon tax, such as carbon intensity reduction, Armington trade elasticity and energy supply elasticity, the conclusion of the research state that a carbon tax in order to be effective should be initially implemented with a low rate otherwise it could be detrimental to some sectors. Moreover, the performance would be improved only if the government decisions would involve the combination of different related policies such as the low carbon tax and the low-carbon energy subsidy.

I decided to refer to this research because the implementation of the carbon tax in China still presents vague points and it is difficult to find consistent information that reveal more details. The research is supported by evidences and specific calculations and I think it can represent a good starting point to set an argument.

2.2.3 Coal taxation

Besides the implementation of a carbon tax, in 2014 China also embraced the reformation of the resource taxation system, which directly monitors the coal usage and have effects on China's coal industry. The Ministry of Finance (MOF) and State Administration of Taxation (SAT) announced the decision to shift from a volume-based tax to an ad-valorem tax, which is structured considering the actual price of coal and do not take into account the quantity exploited. The reasons beyond this decision are based on the fact that a volume-based tax, even if does not rely on the fluctuation of the sources price and avoids the risk of tax dodging, it neither considers supply issues. In case there would be an oversupply or a shortage of coal it would not either balance its value whether changes will occur. Moreover, the volume-based tax causes an increase

of the expenses of source enterprises because local governments often add fees to gain more revenues[40]. These issues can be bypassed by the choice of an ad-valorem tax because, in case the market would be overheated, the tax rate would increase the cost of sources and would set a new balance; supplementary fees would not be necessary because the price of coal would bear the inflation effects, which would be compensated for the increase of tax revenue[41].

Currently, China's coal production capacity is much higher compared to coal demand and the decision to shift to an ad-valorem tax could represent a way to assist coal industry in managing its revenues and expenses.

2.2.4 The effect of carbon pricing on the energy sector

Putting a price on carbon emission is a delicate operation that requests a careful making-decision process in order to help industrial sectors to minimize risks without damaging their business. This mechanism is aimed to reflect the social, economic and environmental costs of climate change, but in practice may be not successful in covering the actual damages because of the impossibility to predict other factors such as technology costs or market competitiveness. For this reason, in order to be effective it must be combined to the use of other tools and strategies.

As already discussed, governments can exploit carbon pricing as a tool to cope with emission reduction through means such as cap-and-trade system and carbon taxation, while taking advantage of a new source of revenue that could compensate the higher prices that affect business or individuals, help

[40] Liu H., Chen Z., Wang J., Fan J., *The impact of resource tax reform on China's coal industry*, Energy Economics 61 (2017) 52–61, Elsevier, 2016, p.53
[41] *Ibidem*

lowering taxes and deficit, or investing in technologies and infrastructures. The ETS, on one side, guarantees the containment of environmental issues and represents a flexible way for industries to manage their business at flexible prices, while on the other side, the carbon tax works in the opposite direction, assuring the value of the carbon price when the rules governing the process of emissions containment are not well delineated yet. The initiatives for the adoption of carbon pricing have almost doubled during the last 5 years, counting in 2017 42 national and 25 subnational jurisdictions that have involved it in their policies[42].

However, the ETS and the carbon tax do not constitute the unique mechanisms providing the set of a carbon price, the international community promotes also other kind of projects. The Results-Based Climate Finance (RBFC) is one them, and operates encouraging reforms, sectorial investments and promoting private businesses to invest their capital in green projects, pushing enterprises to the voluntary adoption of an internal carbon price. The internal carbon price is a practice that is making its way through the innovations of the industrial sector, but before analysing this new trend, I would still concentrate my attention on the importance of national carbon pricing, focusing on the effects that will cause in the energy sector.

According to the inquiry by the World Resources Institute "*Putting a Price on Carbon: Reducing Emissions*", the economic theory demonstrates: CO_2 emissions are a threat for climate change, pricing emissions will shift their costs from society to direct them towards the responsible bodies; the more the prices of goods and services produced from burning of fossil fuel are high, the more companies are encouraged to reduce emissions. If CO_2 emissions are not priced and there is a lack of adequate policies, the costs of damages will not

[42] Carbon Pricing Leadership Coalition (CPLC), *Carbon Pricing in Action*, www.carbonpricingleadership.org

rely on neither producers nor consumers[43]. Instead, if emissions are priced markets will work as usual, but the responsible for environment pollution will have to respond to regulations and cover the due costs.

During the last years, the coal demand has seen a decrease and the major cause can be ascribed to the responses of energy sector to carbon pricing changes, also considering the always more effective climate regulations. The inquiry takes into account the effects that carbon pricing will cause on the emission reduction in short term and long term, focusing on both electricity and transportation sectors, since they represent the main source of air pollution. Even if the forecasts are shaped through the utilization of U.S. Energy Information Administration (EIA) data and concentrate the attention on United States, in my opinion, the study can help creating a general view on the possible outcomes that China could face during the next years, since both countries are characterized by a developing economy and still lack of a proper emission containment system. For the purpose of my study, I will only consider the issues related to coal usage and the implications on electricity sector.

In general, it is possible to state that carbon pricing directly influences the electricity consumption trends. The reason beyond such variation is related to consumption behaviour of consumers, which changes depending on the fluctuation of prices. If electricity price increase, the consumption will decrease and consequently, if the demand for electricity lessens, the use of coal lessens too, because fossil-fuel plants have high operating costs[44].

Therefore, in the very short run, the situation would see a drop of electricity generation from coal units, since coal has the highest carbon emissions rate. Based on forecasts on the long run, educated consumers would perceive the tool of carbon pricing as a regular part of the policies governing

[43] N. Kaufman, M. Obeiter, E. Krause, *Putting a Price on Carbon: Reducing Emissions*, World Resources Institute, 2016, p.5 and 6
[44] *Ivi*, p.10

the energy consumption and that would mean a high responsiveness to the need of containing the expenses related to the electricity use[45]. In this framework, the EIA projections are quite pessimistic about the variations of electricity supply, since the agency holds to be true that any other technology would not be more competitive than fossil fuels. On the other side, the tendency of investing in the construction of plants working with lower carbon emissions would help climate change mitigation and the carbon price would favour emissions reduction[46].

Finally, in the very long run, the research states that also private business of independent investors would be affected by the implementation of carbon pricing, causing an increase of investments in green technologies. This will result in a competitive advantage because the carbon price will be strong and predictable, while the acquired knowledge coming from the acquisition of new technologies will boost productivity revenues.[47] The process, in order to be effective, should be associated to strong investments in consumers' education to finally strengthen the concept of cost-effective energy efficiency.

For what concern the projection of the effects of carbon pricing policy in China, it is possible to refer to data collected by China Carbon Forum (CCF), ICF and SinoCarbon "*2017 China Carbon Pricing Survey*". The survey takes into consideration the expectations of 260 China-based stakeholders on the future of China's carbon policies. It is worth noting that the publication of the survey is dated back to November 2017 and refers to data collected between March and July, when the intention of the government of implementing the national carbon market in December was not declared yet. The experts of carbon markets were asked to answer questions concerning the China's instituted carbon market pilots and the national emissions trading system, the impact that the national ETS will have on investments, the future emissions

[45] *Ivi*, p.11
[46] *Ivi*, p.13
[47] *Ivi*, p.14

reduction targets and the possibility of linkage of China's ETS with other carbon markets.

The survey provides experts' projection about the average carbon price for the next years and precisely shows that the ETS will be regulated according to the following previsions: CNY 38/ton in 2017; CNY 51/t in 2018; CNY 74/t in 2020 and CNY 108/t in 2025. Moreover, it also provides a comparison of the recent data to the ones collected from the last surveys expectations of 2013 and 2015. We can see that the forecasted values result to be much higher than the ones expected in 2015: CNY 39/t in 2017; CNY 45/t in 2018; CNY 56/t in 2020 and CNY 70/t in 2025[48]. The uncertainty about the future forecasts is strong, but in general, the prices are expected to rise constantly, with substantial increase from a period to another.

For what concern pilots' prices instead, the data shows that participants to the previous surveys, for both 2013 and 2015 projections, had too high expectations on values whereas pilots' prices of 2016 were actually lower[49]. The main factor affecting pilots' carbon price is definitely considered to be the "cap setting and fee allocation", while a small part believe that it is due to the impact of government intervention.

The inquiry on the trend of emission reduction shows that the majority of experts are confident that China by 2025 will continue to use a target based on emission intensity whereas the minority retains that there will be a shift to an absolute target, which, as said before, does not consider national GDP growth and may slow economic development. The ETS, the carbon tax, companies' disclosure and energy allowances trading are considered the policies that will help climate change mitigation and emission reduction. However, the 85% of participants stated the need for a rules-based flexibility,

[48] *Ivi*, p.21
[49] *Ivi*, p.12

such as a market stability reserve, to control price fluctuations and the supply of allowances.

2.2.4.1 Internal carbon pricing

As previously mentioned, the internal carbon pricing is a practice always more present among the industrial policies. This financial tool has proved to be optimal to identify climate risks and potential revenues, and guarantees assistance in deciding investment strategies starting from the analysis of the impact of climate policies. Many companies decide to adopt a carbon price as a transition tool, to embrace low-carbon activities and green investments.

In 2017, about 1,300 companies disclosed information about their strategies to CDP, an organization that runs global disclosure, showing an increase of 11% compared to 2016 and about 700 companies stated their will to join the group during 2018-2019. The sectors mainly involved are utility and energy, responsible for the majority of emissions, while healthcare discloses much less information[50]. The majority of the companies decided to put an internal carbon price to manage risk, and most of them are located in countries where carbon pricing is or will integrated in national or subnational policies[51]. The embracement of this tool represents a way for companies to take a place in a market that is adapting to new policies, and makes possible the creation of a strategy through public dedication and carbon pricing coalitions. Clearly, making available information about carbon price, beside the direct advantages brought to companies, constitutes an evaluation tool for investors and

[50] N. Bartlett, H. Cushing, S. Law, *Putting a price on carbon: Integrating climate risk into business planning*, CDP, 2017, p.8
[51] The World Bank, *Carbon Pricing Dashboard*, www.carbonpricingdashboard.worldbank.org

consumers that call for transparency in order to reduce the risks, taking care of their interests and fostering investments in clean energy.

However, set a specific internal carbon price presents different challenges since companies may not have a clear idea of the path to follow. Therefore, the guidelines of *Climate Business Leadership Criteria on Carbon Pricing*[52] suggest to companies a scheme to follow when approaching to decisions about price, it is to say: establishing a high carbon price in order to be influent in the investments panorama; adopting a price through a mechanism consistent with a country specific economy and policy to lessen future inconsistences; reporting improvements in order to enhance transparency. Generally, an internal carbon price is set according to two main options: a shadow price or an internal carbon tax.

For what concern the first option, it affects companies' decisions about investment projects, directly involving profitability ratio and predicted cash flows. The shadow price is determined through the establishment of a carbon value decided by the company that is included into each investment choice and is applied to the produced carbon emissions. The value results by the influence of already existent carbon pricing policies in the place where companies are headquartered, considering an "expected real price" making hypothesis about exchange rates or commodity prices[53]. The shadow price is a long-term financial tool that is aimed to modify the business model of a company; in the long period, it will reveal its efficiency compared to the evolution of national regulations by looking at its proximity to the actual value. If the value will be close to the mandatory one, the company objective of reducing risk will be satisfied, if the value will be higher than the mandatory one, it means that the

[52] Caring For Climate, *Put a Price on Carbon*, www.caringforclimate.org: "The UN Global Compact together with UNEP and UNFCCC secretariat and Caring for Climate partners – WRI, CDP, The Climate Group, UN Foundation and Principles for Responsible Investment – are calling on companies to become Carbon Pricing Champions by aligning with the Business Leadership Criteria on Carbon Pricing" cit.
[53] Alberola E., Afria M., *Internal carbon pricing: a growing corporate practice*, Enterprises pour l'Environnment (EpE) and Insitute for Climate Economics (I4CE), 2017, p.17

company's low-carbon approach will be more challenging than the national procedure. The inclusion of a carbon value in investments decision may be transitory or could evolve in different prices according to the needs and projection of a company; moreover, it may also vary according to the activities and projects. For instance, it has been calculated that a value between $30 and $40 per tCO_2e would be sufficient to let companies decide for a shifting towards gas and encourage further investments[54].

The second option considers the scheduling of a fee that is related to the generated carbon emissions and that will result in the increase of the operating costs. The aim is to reduce emissions in the short period and to foster innovation in the long period. The internal carbon price, this way, will be calculated on the basis of carbon emissions and for this reason the company must examine emissions generated by facilities, consumption of electricity and indirect waste activities for each business unit. This approach could be problematic in case headquarter country has already implemented or is willing to implement a carbon tax and could bring the need of valuing other options. Moreover, problems in the accounting process may arise. That is why companies are more disposed to adopt a shadow price rather than an internal carbon taxation.

Finally, implicit carbon price or real cost of low carbonisation can be considered a further way to set a value on CO_2 emissions, including all those measures and initiatives directed towards climate change mitigation. For this reason, all the companies involved in energy projects and clean development are influenced by an indirect determination of a carbon price.

Besides the purposes of companies, governments and financial institutions are making a good use of internal carbon pricing too. For example, governments uses this tool to estimate the social cost of carbon, the marginal abatement costs derived by national targets and expectations, the future values

[54] *Ivi*, p.25

of emissions allowances. According to data recovered by the World Bank Organization, the value varies from USD 5/tCO_2e to over USD 400/tCO_2e, depending on the country, year and sector[55]. Financial institutions exploit internal price to evaluate their carbon footprint and the potential emissions caused by new plans.

The decisions about the kind of option to adopt depends on the objectives of a company, therefore understanding the direction to follow is the first step to consider before setting a price. For instance, if the primary purpose is to accumulate funds that have to be allocated in investments in energy efficiency or green technologies, the best choice could be represented by an internal tax that would lessen the weight of responding to the reduction of emissions. In other cases, if the purpose were to help preparing strategies considering the carbon price determined by national policies and its effect on the company operations, a shadow price would be ideal[56].

2.3 Greening the banking system

Even though the concept of sustainable banking presents several interpretations depending on different practices and different local contexts, is directly linked to the evolution of the green finance system and is role is obtaining more and more relevance. In general, the regulatory agencies and banking associations from developing markets that are part of the Sustainable Banking Network (SBN) recognize three main elements when speaking about sustainable banking: environmental and social risks management for

[55] The World Bank, *Carbon Pricing Dashboard*, www.carbonpricingdashboard.worldbank.org
[56] *Executive Guide To Carbon Pricing Leadership: a Caring for Climate Report* , UN Global Compact, 2015, p.10

investments and lending; support to green industries or projects through investments and lending and initiatives leading to the greening of their environmental and social footprints[57].

Through environmental risk management (ERM), financial institutions are able to recognize and handle environmental risks that must be identified when there is the will to operate through financial operations as credit, loan and investment. For instance, a bank investing in a project realized through a polluting mechanism may have to face the dangers brought by environmental damages that would result in high compensating costs. Instead, the ERM not only avoids further costs, but also helps enterprises to obtain higher revenues given by the competitive advantage of new products originated by a clean mechanism. In this framework, commercial financial institutions refer to the Equator Principles as a risk management scheme through which rules about duties and obligations of borrowers and lenders are defined. In doing so, the risks are lowered and the chances of a positive business performance are enhanced. To sum up, the ERM is fundamental for companies as well for institutions for various reasons: it helps assessing the negative impact of the activities of a company on the environment that can result in financial risks, legal risks and reputation risks and help institutions to avoid succumbing to credit/loan risk, investment risk, liability risk and reputation risk. For instance, credit risk is associated to the impossibility of the borrower to perform its contractual conditions and causes the creditor or bank to face the financial losses due to a wrong expectation about its investment.

The banking sector assumes a fundamental role in the emerging markets and in the environmental issues scenario since it provides capital to industries and has the possibility to address investments to sustainable projects, rather than

[57] *Greening the Banking System - Experiences from the Sustainable Banking Network (SBN) (Background Paper for the G20 Green Finance Study Group),* Sustainable Banking Network and International Finance Corporation (IFC)

fostering obsolete technologies. To assess the extent to which a bank can be defined "green", the factors to observe are the grade of commitment and adoption of green financial tools, the financial flows and priorities of investments, the quality of financial assets from an environmental point of view and the consequences of the bank's activities on the environmental and social framework[58]. The motivation beyond the choice of going green must be found, on the one hand, in the necessity to manage environmental and social risks and, on the other hand, in their will of taking a competitive advantage in the international market. However, the voluntary adoption of these measures from banking sector in developing countries still misses to reach a significant rate if compared to international leading banks initiative.

At the end of 2015, the majority of Chinese banks had adopted the guidelines to assess environmental and social risk management, showing an important signal towards sustainable development. Already in 2007, the People's Bank of China (PBOC), China Banking Regulatory Commission (CBRC), and Ministry of Environmental Protection issued the "Green Credit Policy", which brought to the creation of a national database that states the environmental compliance of non-financial firms, inviting banks to not make loans to transgressors. The Green Credit Policy has been followed by the implementation "Green Credit Guidelines" issued by the CBRC in 2012, by the "Green Credit Statistics System" in 2014, regulating the issue of green loans, and by the "Green Credit Key Performance Indicators" (KPIs) in 2015, monitoring green banking performance. Much has been done also in the framework of energy efficiency and emission reduction thanks to the investments from IFC.

If compared to other emerging markets, China's government has evidenced a high participation through policy-based initiatives, promoting

[58] *Ibidem*

coordination of bodies at all governance levels. Implementation of such regulations, however, is still a problem in local areas and the main barrier is constituted by the need of embedding the concept of sustainability in the core business of the banking system.

2.4.1 The issuance of green bonds

Along with the development of the banking system, the bond market is also experiencing the evolution of part of its structure thanks to the issuance of the so-called "green bonds". Green bonds issued by the World Bank from 2008 to 2016 account for USD 10.2 billion, and are emanated in 18 currencies[59], while the global total amount reaches USD 80 billion for the majority coming from Chinese market[60]. It is esteemed that Chinese green bonds amount to 2%, whereas the international issuances amount to 0.2%[61].

The factor that distinguishes green bonds from regular bonds is the aim to finance projects with a low or null environmental impact, helping the process of climate change mitigation and adaptation. Investors as well by issuers can appreciate the advantages of investing in projects through green bonds, because they constitute a mean that fosters environmental safety while ensuring investments in a system that sees its climate policies continuously revised. However, it is not always possible to identify in an exact way their nature because of the different interpretation around the concept of what is considered a green project and what is not. In order to avoid that the local market context

[59] World Bank Green Bonds, *What are Green Bonds?*, http://treasury.worldbank.org/cmd/htm/WorldBankGreenBonds.html
[60] Climate Bonds Initiative and the China Central Depository & Clearing Company, *China Green Bond Market 2016*, 2017, p.3
[61] *Ivi*, p.2

will bring misleading definitions, a series of Green Bond Principles (GBP) is offered for the voluntary consultation.

Fig. 8 Green bonds issuance by China

Source : Climate Home News

The "educational process" represents the first step for the implementation of green bonds. It serves as a demonstration for their issuance and sets the initial targets and quotas to launch the mechanism. Tax incentives should be dispensed to make green commercial bond tax-free, while interest rates on green activities should be lowered.

China, in order to guarantee transparency and attract foreign investors, must organize the establishment of a system of green bond certificates according to specific measures. In the Foreign Direct Investments (FDI)

framework, the country should operate through the provision of pension funds, sovereign wealth funds and insurance funds[62]. The Chinese market issues different types of green bonds, most of them are defined "onshore", while "offshore" and "Green Panda" bonds are present at a lower rate. The onshore green bonds are approved by commercial banks and are made available for Chinese investors, the offshore bonds are issued by Chinese institutions but are listed on international market stocks, and finally, non-Chinese institutions provide the issuance of the so-called Green Panda selling them on Chinese market.

The People's Bank of China calculated that the country needs investments between USD 305 billion-640 billion per year to reduce the effects of pollution, but the public investment alone will not be able to balance the damages. For this reason, green bonds seem to represent a potential solution to meet the national target, but they need to attract more investments coming from private investors.

2.4 Corporate environmental disclosure

Notwithstanding the increasing awareness of the importance of environmental care, companies' disclosure of information about greenhouse gas emissions still lacks of sufficient elements to assess the business performance in terms of climate impact. Corporate sustainability is becoming a key factor when it comes to investment decisions, since governments in both developed and emerging economies foster climate policies increasing the risk

[62] The International Institute for Sustainable Development and the Development Research Center of the State Council, *Greening China's Financial System,* International Institute for Sustainable Development, 2015, p.266

of incurring onerous sanctions and loss of reputation. However, the growth of disclosure rate does not seem to respond to the market needs, accounting in the period between 2010 and 2014 an increase of only 40%[63]. In general, it is possible to evaluate the environmental commitment of a company through the observation of the carbon intensity data and fossil fuel reserves data. The principle shows the lower the rate of carbon intensity is, the lower the investment risk is, while data about fossil fuel reserves allow the calculation of the potential greenhouse gas emitted[64].

In China, corporate disclosure is regulated by different entities through guidelines about green credits, environmental disclosure and social responsibility of listed companies as well as State Owned Companies. Different stock exchanges require different types of information ascribable to different regulations, but only companies violating national or regional standards are compelled to disclose information, while companies in compliance with the targets are invited to voluntary disclosure. The quality of information granted, however, may not full reflect the actual situation, and transparency may only be illusory.

[63] Corporate Knights Inc. (CK), *Measuring Sustainability Disclosure: Ranking the World's Stock Exchanges,* Aviva, 2016, p.14
[64] *Ivi*, p.27

CHAPTER THREE
DRIVERS AND BARRIERES OF RENEWABLES ENERGY INVESTMENT

At the beginning of 2017, China government announced an USD 360 billion investment plan to be destined to renewable energies by 2020, resulting as the global leader in clean energy worldwide. According to Greenpeace, every hour a new wind turbine is built and solar panels covering the same area of a soccer field are installed. The country's plan has already met the national target of energy efficiency, carbon intensity and share of green energy sources, showing an ongoing commitment for the reduction of environmental damages.

Although the growth of energy production by sources such as solar, wind and hydro power has seen a huge increase and the positive qualities of their usage have been largely discussed, negative implications must be considered too. Renewables sources are not always available due their production mechanism: geographic limitations, expensive installations, difficult storage processes and energy transmission problems are just few examples. The economic implications caused by the decrease of coal employment cannot be neglected, but still, the future of climate safety depends on the investment and development of new sources of energies and must be encouraged through politic renovation and citizens' education.

Statistics show that prices of green technologies have already begun to decrease thanks to an always more significant investment and installation of plants and a following reduction of cost of materials used to assemble those systems. However, financing this kind of projects is still unbearable and benefit from the positive effects on both environment and economy may request decades.

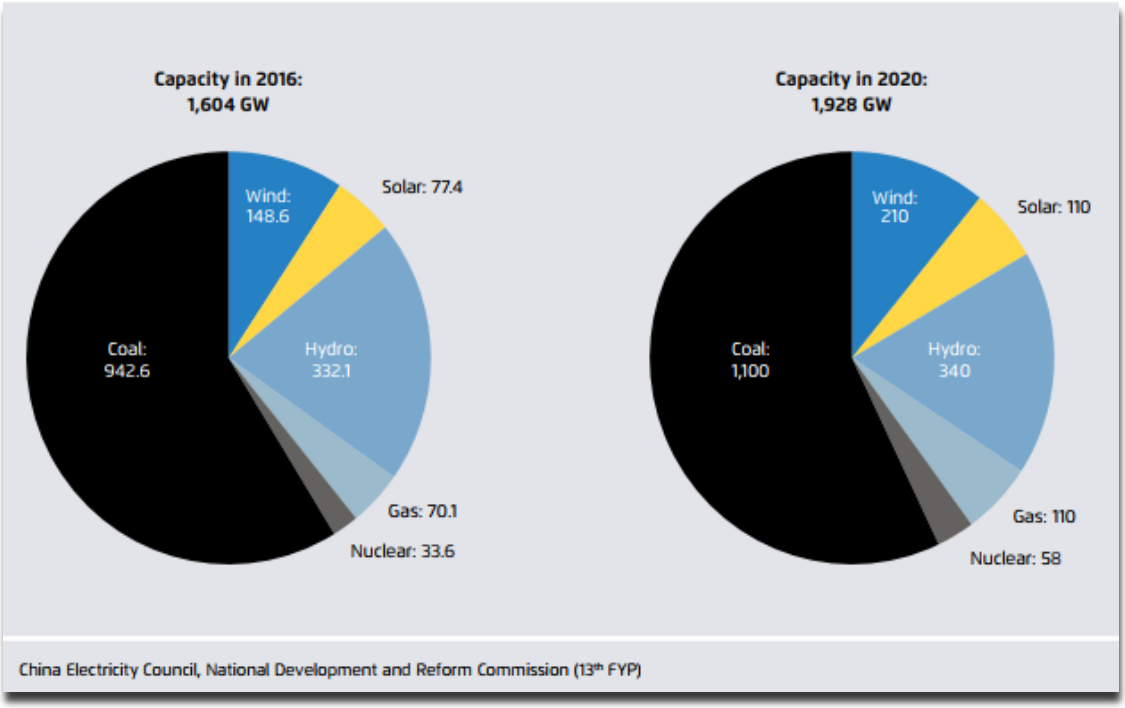

Fig. 9 Installed generating capacity of China's power sector in 2016 and 2020 in GW

Source: Energy Transition in the Power Sector in China: State of Affairs in 2016

3.1 Cost of energy

The most evident barrier to energy investments is constituted by the evaluation of the cost that have to be faced in order to produce a certain quantity of energy and the way it will affect the profits during the entire cycle of industrial production. In order to understand the economic burden caused by the adoption of new technologies, industries try to assess this kind of data through the calculation of Levelised Cost of Energy (LCOE).

LCOE allows the measurement of "per-kilowatthour cost of building and operating a generating plant over an assumed financial life and duty cycle"[65], taking into account the initial capital investment, the cost of maintenance of the pants, fuel costs, operational costs and utilization rate. This way, it is possible to compare the costs caused by different technologies that presents different life spans, risks, returns and capacities considering both variable and fixed costs, facilitating the decisions that are critical to the development of new projects. Clearly, fuel costs and maintenance costs that are generally high for traditional energy production mechanisms affect heavily the final LCOE, and tax incentives and state policies can influence its calculation too.

In addition to the calculation of levelised costs, another evaluation that makes possible to understand the level of competitiveness of a certain technology is the examination of the avoided costs. Through the avoided costs is possible to assess the measure of annual economic value of a project, which summed to its financial life and divided by the average annual output, results in the levelised avoided cost of electricity (LACE)[66]. Compared to LCOE, it will give a wide view of the advantages or disadvantages of the new investment. However, when coming to decisions, investors must consider that the effectiveness of such calculation is less precise for markets that are not fully regulated, since variable costs cannot be predicted exactly.

[65] U.S. Energy Information Administration (EIA), *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2017*, 2017, p.1
[66] *Ivi*, p.3

$$LCOE = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:

LCOE = the average lifetime levelised cost of electricity generation;

I_t = investment expenditures in the year **t**;

M_t = operations and maintenance expenditures in the year **t**;

F_t = fuel expenditures in the year **t**;

E_t = electricity generation in the year **t**;

r = discount rate; and

n = economic life of the system.

Fig. 10 Levelised cost of energy formula

Source: Lumina Decision System

The reduction of cost of electricity production from renewable energy is already considerable and levelised cost of energy for solar and wind technologies has already seen a drop of 6% compared to 2016 data, but it is still not sufficient to state an economic advantage to encourage industries to give up on producing energy from traditional generation mechanisms. It has been estimated that in 2017 the average cost of installation of solar panels varied between USD 2,000 to USD 3,700 per kilowatt depending on the scale of the plant, while wind systems installation expenditure varied between USD 1,200 to 1,700 per kilowatt[67]. The risks brought by such high investment make investors prefer continuing to finance conventional projects, whose risks can be lowered because relapsed on or shared with consumers. In order to discern the convenience of green technologies, investors must consider to which extent the high initial costs can be spread out on an entire installation life cycle. This way,

[67] Uninon of Concerned Scientists, Inc. (US), *Barriers to Renewable Energy Technologies*, https://www.ucsusa.org/clean-energy/renewable-energy/barriers-to-renewable-energy#.WnzTFa7ibIV

solar and wind power costs seem to be the lowest compared to coal, which expenditure in 2017 respectively amounted to USD 43-53 megawatt/hour, USD 30-60 megawatt/hour and USD 60 megawatt/hour[68]. Considering the costs to bear for fuel, maintenance of plants and capital to invest, some renewables result to be more cost competitive than traditional energy because in the long run they do not request additional expenditure. That is why is interesting to examine in depth China government decisions of adopting alternative solutions and state the intentions about the future of the country energy production.

Today, the biggest investment of China in renewable technologies in represented by hydropower, which contributed in 2016 to the 80% of the total clean energy production of the country. Hydropower installation, however, shows several difficulties and some experts attribute to the development of this kind of projects further environmental damages, since building the systems contribute to huge changes in the locations layout. Ecosystems, forests and population are in danger and water scarcity may compel China to find alternative ways of green energy production. The 13th Five-year Plan, in fact, aims to develop in a large scale solar and wind power, increasing the production to double today's amount. The government supports the mechanisms through the feed-in tarrif (FiT), a tool used to encourage the generation of green energy and that guarantees to producers a set price from their utility according to geographical resources. Installations rates saw a huge increase in 2016 with 34 GW new solar power capacity, setting a new world record.

[68] *Ibidem*

Indicator	Unit	2015	2016	Year-on-Year change (±, %, pc. point)
Power production	GWh	5,693,800	5,989,700	5.2
Hydro power	GWh	1,111,700	1,180,700	6.2
Thermal power	GWh	4,186,800	4,288,600	2.4
Nuclear power	GWh	171,400	213,200	24.4
Wind power	GWh	185,300	241,000	30.1
Solar power	GWh	38,500	66,200	72

Fig. 11 2016 National electric power industry statistics

Source : China Energy Portal

Another issue that cannot be ignored when talking about energy costs is that China covers an area equal to 9.597 million km², which implies a huge distribution expenditure. Transmission from generation to end consumers over long distance networks creates significant power losses because energy is transformed in heat, causing additional costs to the already beard expenses. In general, the total distribution losses amount to 8-15%, depending on the length and efficiency of the transmission line[69]. The energy produced in China mainly comes from the northern and western areas and must be transferred to the eastern costs, which request the 30% of total consumption of the country. According to recent researches, about 30% of the energy produced from solar and wind power in 2016 was wasted because of the lack of a proper distribution system, a quantity that would have been sufficient to meet Beijing needs for a whole year. For this purpose, experts are working to maximize energy transfer using ultra-high-voltage (UHV) technology. It has been estimated that the creation of a hybrid system whose input would have been constituted by energy

[69] *How big are Power line losses?,* https://blog.schneider-electric.com/energy-management-energy-efficiency/2013/03/25/how-big-are-power-line-losses/

produced from both renewables and coal power could save 16,000 people from pollution related diseases and the same time reduce CO_2 emissions for 340 million tons[70]. However, even if government invested for the creation of new 12 lines of transmission, only three will be destined to provide energy from renewable resources, while the provisions will continue to mainly rely on the availability of resources depending on the features of the territory: the eastern areas will continue to use energy from fossil fuels, and clean energy will continue to not be fully exploited. Considering also that wind and solar power is not always accessible due to its natural characteristics, the transmission is not always fully operating causing loss of money to people investing in this kind of technologies. The most recent data about energy distribution losses date back to 2014 and accounted to 5.47% of the total output, showing a gradual decrease during the years (the amount in 1981 was 8.25%).[71]

Chinese government aimed to improve the regulations of transmission industry through a new reform for electricity market, recognizing the need to separate the costs due to the transmission and distribution process from retailing, calculating the real costs of the mechanism. After 2004, during which China suffered from a serious shortage of energy, the massive investments in energy generation have led to an increasing surplus. The excessive production has conducted the country to become one of the biggest exporter of electricity in the world, with a total of 18.91 billion kWh export in 2016[72], and thanks to the development of UHV technology, its plan seems to be even more ambitious. In the future, China will be able to transport energy at longer distances, aiming to enter markets such as India and Germany across the so-called New Silk Road.

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[70] Peng W., *China's Silver Bullet: Can the Transmission Grid Solve China's Problems?*, 2017, https://www.newsecuritybeat.org/2017/10/chinas-silver-bullet-transmission-grid-solve-chinas-problems/

[71] Electric power transmission and distribution losses (% of output), https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS?end=2014&locations=CN&start=1971&view=chart

[72] https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html

3.2 The effects of energy mix's changes

The development of industrial production is one of the main force driving Chinese economic growth. Manufacturing, services, agriculture represent the three major sectors of industry, which contribute in large measure to the increase of annual GDP. In particular, the country has obtained the first place in international market for the production and exportation of manufacturing goods such as iron, steel, aluminium, textiles, electronics and many others. As a result of the great expansion of the industrial sector, China requests enormous quantity of energy to keep on producing goods and to let the country state its presence in international market. The latest innovations brought in the energy generation sector, the new technologies and the use of renewables, may lead industry to face changes in the regular industrial processes and expenditure. Energy prices are relevant for industrial production since higher energy prices can result in increasing costs for related products.

The cost of electricity production mostly depends on the kind of source used to generate energy: the more the supply of raw commodities is limited the more their price will rise or it will push investors to find cheaper and alternative sources that will equally affect the final cost. Carbon cost, demand, supply constraints, time to delivery are all factors affecting the fluctuation of electricity costs and are directly transferred on the industry profits, increasing its risks since these factors are not always predictable. As pointed out, the levelised costs of resources help investors to understand the impact in terms of economic burden that must be beard to produce a certain quantity of electricity. Data demonstrate that the use of alternative energies, in most cases, are more convenient than the use of conventional ones, since in the recent years countries have diversified their energy mix and the electricity more than ever is generated by renewable sources, leading to a general decrease of their prices.

Referring to the most evident example, the exploitation of coal reserves is leading the world to face a future shortage that will not make possible its employment anymore. It is estimated that, at current rates of production, coal supply will last about 150 years, and this could mean a natural rise of its price compared to other resources, beyond the fact that finding alternative ways to produce energy will be compelling.

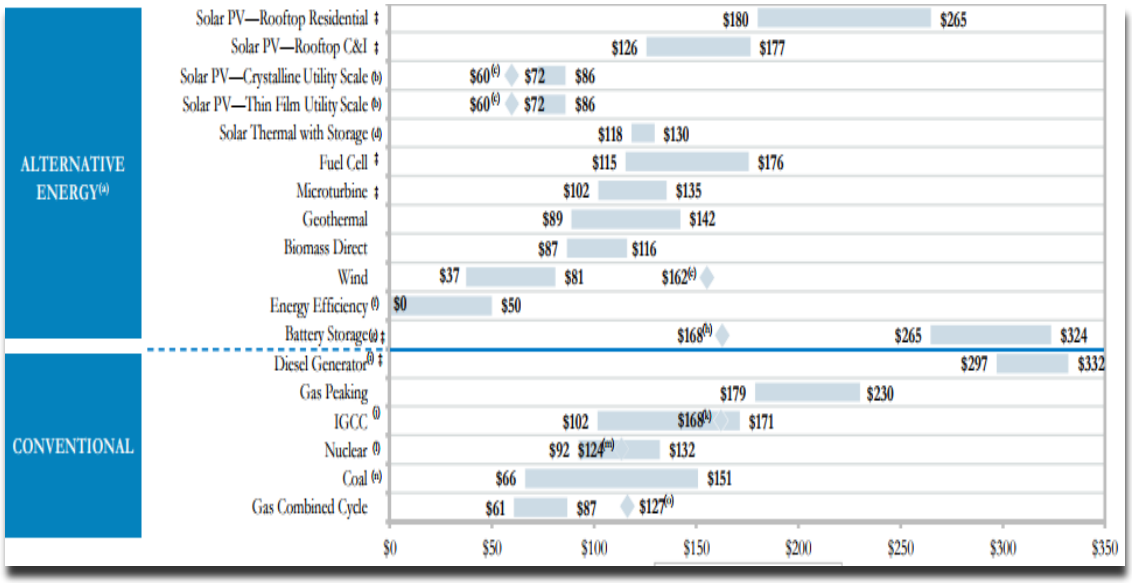

Fig. 12 Unsubsidized Levelised Cost of Energy Comparison (USD/MWh), 2014
Sources: Lazard's Levelized Cost of Energy Analysis - Version 8.0

Neverthless, the biggest part of China's energy mix is constituted by the use of coal: from 2002 to 2012, the country's rapid growth led to a big demand for this source and its price consequently rose in a rapid way. Despite the price increase, the country still benefits from its economic advantages since China's territory presents the greatest coal reserves of the world following United States and Russia, its infrastructures are already suitable for its usage and the low labour costs still guarantee high profits. Besides those factors, a key role is

played by the regulation of energy prices, the Chinese government aims to control them in order to reduce the burden and to facilitate economic and social development. Before the 1990s, both industrial prices of coal and power energy were submitted to government regulation, which fixed them at a low level below production costs. Later, in order to foster competition between coal industries, the coal prices were liberalized, whereas electricity generation industry still had to pay a fixed price to buy the source. It has been calculated that coal price was about 46% below the price required by government, and even if the weight of such regulation has been lowered after 1999, prices are still manipulated by SOEs[73]. Moreover, many reforms were implemented to foster energy savings and emission reductions including the elimination of different coal-related fees.

Electricity prices in China result to be much lower than prices in other developed market. Prices are set according to three categories: residential daily power consumption, agricultural power consumption, industrial and commercial power consumption. During the last years, electricity price for mass industrial users has seen periodical adjustments determined according to the setting of a basic price and a meter price. The basic price is established according the enterprise's transformer capacity or maximum demand and an agreement between supplier and consumer fixes the costs of due fees without taking into account the inflation of actual consumption, whereas the meter price is calculated on the basis of quantity of energy effectively consumed[74]. Since 2002, the National Energy Administration is working to make adjustments in the pricing system, aiming to guarantee a market-oriented determination of prices rather than a totally controlled system by government. However, the

[73] K. Ju, B. Su, D. Zhou, J. Wu, *Does energy-price regulation benefit China's economy and environment? Evidence from energy-price distortions*, Energy Policy 105 (2017) 108–119, Elsevier, 2017, p.108

[74] *Mass industrial electricity price may continue to decline in China*, 2016, https://www.pv-magazine.com/2016/07/28/mass-industrial-electricity-price-may-continue-to-decline-in-china_100025589/

equalization of power prices according to the market mechanism is difficult to realise, and reforms have created a conflict between coal and power prices: market coal prices are constantly rising, while electricity prices are fixed, leading to fixed electricity coal prices. The higher costs for coal, that mean higher electricity coal prices, cannot be passed on consumers that benefit from government's fixed electricity prices[75]. After the implementation of the Coal and Electricity Prices Linkage mechanism, industrial and commercial companies benefited from the saving of CNY 30 billion in bills expenditure[76], but the potential inflation issues have brought government to reconsider the idea.

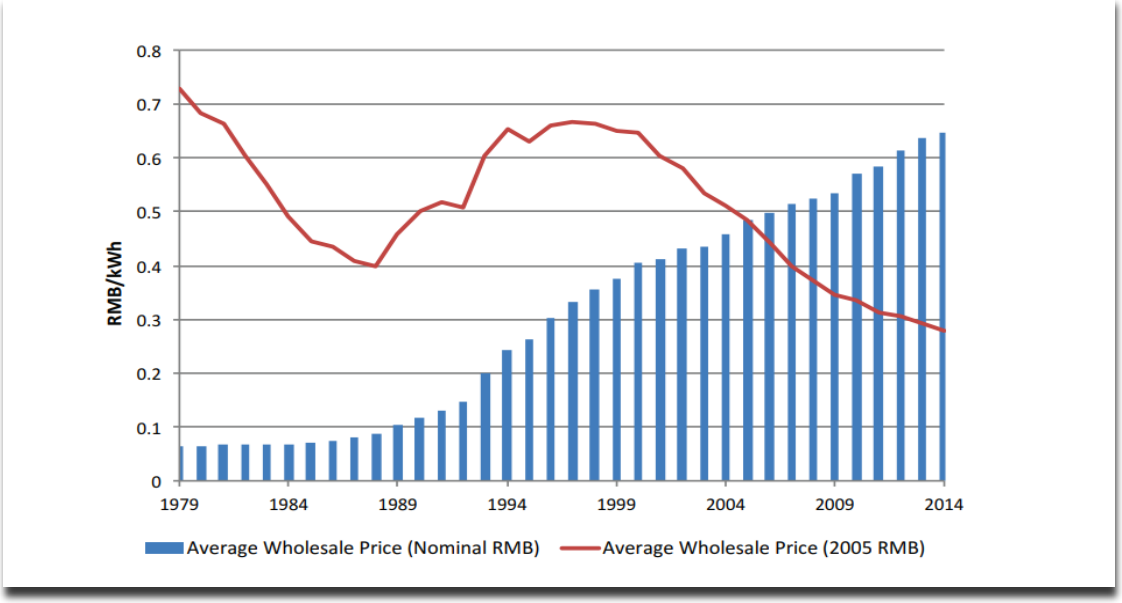

Fig. 13 China's average wholesale price of electricity CNY/kWh (1979-2014)
Source: Key China Energy Statistics 2016

[75]Fridley D., Zheng Khanna N., Hong L., *Review of China's Low-Carbon City Initiative and Developments in the Coal Industry* , China Energy Group, Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory, 2012, p.56

[76] *Mass industrial electricity price may continue to decline in China*, 2016, https://www.pv-magazine.com/2016/07/28/mass-industrial-electricity-price-may-continue-to-decline-in-china_100025589/

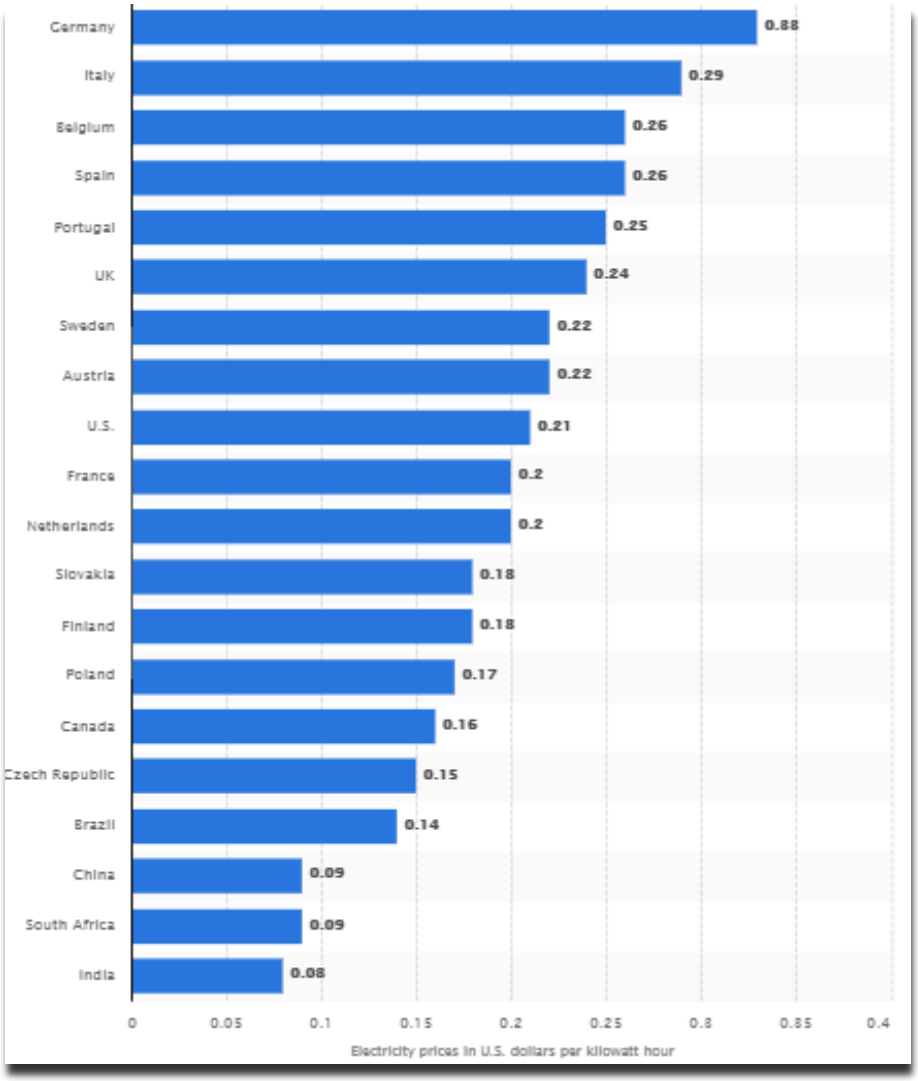

Fig. 14 Global electricity prices by select countries in 2017 (USD/kWh)

Source : Statista

It is right to point out that the data shown in the tables above only have the comparative purpose to state the trend of China electricity prices compared to other nations' tendencies. The tables differ from reference years and currencies, that we know are constantly fluctuating; moreover it is due considering that data do not fully take into account the latest updates for what concern policies and international developments.

	Industrial Electricity Price (US $/kWh) In 2014	*Coal price for generation (US $/kWh) in 2014*	*Gas price for generation (US $/kWh) in 2014*	*Residential Electricity Price (US $/kWh) in 2014*
US	0.0710	0.0241	0.0159	0.1252
China	0.1068	0.0384	0.0778	0.0908
China *minus* US	0.0358 (50% higher)	0.0143	0.0619	-0.0344 (27% lower)

Fig. 15 Electricity price and fuel input price differential with US

Source: National Energy Administration and U.S. EIA

Today, Chinese government is still trying to find the proper combination of policies to balance prices, the mechanism is continuously revised and the proposal of subjecting all power used by industries to market pricing has already shifted to 2020. The Document No.9 issued in 2015, paved the wave for the beginning of renovation of electricity pricing system, giving the possibility to private investors to manage power distribution and sales, fostering competitiveness. However, the contractual terms between energy enterprises and end consumers, such as adjustment of prices according to demand variation, must be redefined. The Chinese government is also working for the creation of electricity spot markets scattered in different provinces. The first will be established in Zhejiang province by the beginning of 2019.

3.3 Potential outcomes: Germany as an example of successful energy transition from fuels to renewables

Industrial production and variations of prices of goods and services may be affected by numerous factors and cause different implications on economy. Finding the reasons beyond the variations of final prices is not easy, it implies a deep analysis of each step of the industrial production chain and a careful study of the conditions that an enterprise must face when dealing with a certain kind of market.

Herein, the intention of my study is oriented to approach the specific consequences that the changes of energy mix in China may entail for the future of the economic development. The comments are made according to hypothesis supported by analysis of experts and are guided by evidences extrapolated by data and examples. The aim is to understand to which extent using renewable energies can have a positive or a negative impact on the overall performance of a business that can consequently influence the economy trend.

Therefore, an analysis of the cost related to the generation of energy based on the kind of source used can represent a starting point of discussion. Different sources are subjected to different kind of processing techniques and need diverse types of installations and plants. Investing in alternative sources, such as sun, wind and water means investing in new types of technologies that cause an initial high expenditure. The availability of such kind of sources, then, constitute a further factor that may affect the profits of investors, because it implies that is not always possible controlling and guaranteeing a constant transformation of energy. In addition, the need of renovating the distribution and transmission system, beyond the issues connected to the source used, represents another sort of expense. The risks connected to high investments and availability of sources may be reflected in the prices of electricity with consequent fluctuations, and Chinese government, that aims to liberalize the

electricity price during the next years, may take a defensive position. The impact on industries could been perceived in the form of higher production costs, derived from higher fees and variable expenses. Obviously, the rising of prices of goods and services are subjected to a variety of factors, first of all the fluctuation of demand and supply, and getting involved in such discourse may result a little ambitious.

The interesting thing to focus on is the generation costs of energy from renewables that in most cases result to be less expensive than the generation of energy from fuels. This way, the high initial expenditure may be compensated by the prolonged use of clean generation systems and the advantages of using alternative sources would not be just limited to the environmental scope. While, a final consideration is directed towards the need of exploring new technologies imposed by the limits constituted by the traditional sources that, at current rates of usage, will soon not be available, and in any case would see an increase of their price conditioned also by the latest restrictions due to the pollution issues.

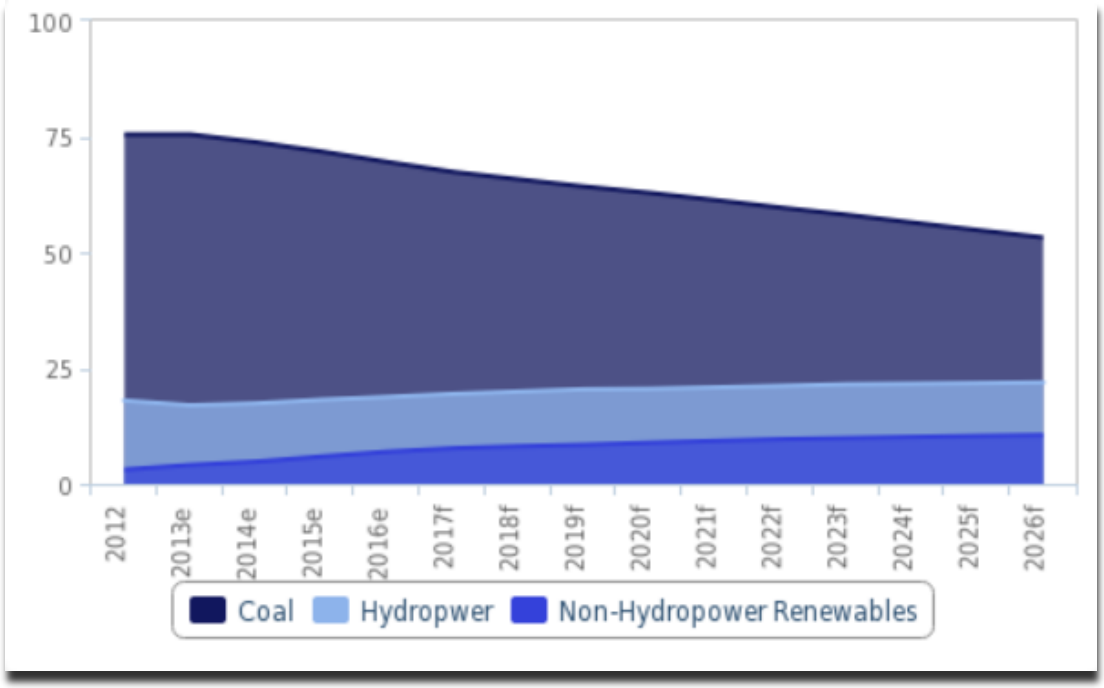

Fig. 16 China's energy mix forecast (% of total energy consumption)

Source : BMI Research

As shown in Figure 14, it is possible to notice that Germany has the highest electricity prices in the world with a charge of 0.33 USD/kWh, without considering additional fees. The country, that has a strong economic power in Europe as well as compared to other countries, is commonly indicated as an example of energy transition, since its policies during the latest years have encouraged the shifting of the country's energy mix from fuels to renewables with great results. The installation of wind turbines and solar panels was a success and had made possible to register in 2016 a production of energy that met the needs of the country's electricity consumption covering its 32%.

On the other side, the rapid transition, that has seen its development in less than twenty years, has forced Germany to finance big infrastructure works to increase power capacity and to build more efficient transmission grids. According to researches, the implementation of the Renewable Energy Sources Act (EEG) had charged Germany's consumers with higher electricity bills, increasing prices by 3%, but relieved the pressure on producers, which saw prices decreased by 8%[77]. Some experts, however, argue that the responsibility of higher prices must be addressed to the huge taxes added: industrial consumers, in fact, must bear a tax burden of 45.5% and therefore, the energy policies would not constitute the only reason for industrial costs' rising[78].

Among the economic benefits stated coming from the investment on renewables, increase in jobs is one of the most cited. In 2016, according to the International Renewable Energy Agency (IRENA) annual review, the energy sector employed 9.8 million people, showing a positive trend despite the cuts made in the traditional sector. In Germany, it has been estimated that by 2020, employments due to the development of clean energy planning and systems

[77] Frondel M., Ritter N., Schmidt C.M., Vance C., *Economic impacts from the promotion of renewable energy technologies: The German experience,* Energy Policy38(2010)4048–4056, Elsevier, 2010, p.4053

[78] Röckel M.*, Energy is expensive in Germany: can this be a good thing?,* 2017, https://www.dotmagazine.online/issues/powering-and-greening-IT/energy-is-expensive-in-germany

creation will originate 400,000 new jobs[79], and while China's plans include the closing of 5,600 mines with a substantial loss of employments, the investment in renewables led to a growth of 3.4% in 2016.

Science and Technology development as well as Research and Development investments are showing positive results for what concern the Chinese ecosystem, workforce and the future innovations. China soon will not have to rely on technology transfer to support new technologies' development and will witness advantages on both environment and economic sides.

[79] Frondel M, Ritter N., Schimdt C. M., op.cit., p. 4053

CONCLUSIONS

The reasons behind the decisions of China's huge investments in renewables can be explained focusing the attention on different aspects. The pattern determining the causes that trigger such mechanism is not easy to delineate and it takes a big effort to discover the intention that moves the country to promote such an ambitious plan.

Defining the government's purposes is clearly the most immediate way to set a starting point of discussion and it can be showed going through the series of initiatives taken in order to join the global momentum. The policies implemented to limit pollution and the new tools adopted to support the reorganization of the financial system are all the results of the need of China to show its commitment to the green cause.

According to this framework, the main driver of the innovation process is constituted by the concern for the social well-being. A society whose members suffer from the lack of the basic necessities such as safety and health cannot help a country's development. In turn, a country investing in people's welfare will enjoy the advantages of a dynamic economy and will give rise to a continuous process of innovation.

Nowadays, health issues are a serious topic in China. Every year people lose their lives because of the inhalation of the fine particulate matter (PM) that has been recognized as responsible for lungs diseases and heart attacks. According to researches, it has been estimated that in China air pollution causes the deaths for an amount of 1,6 million people every year, it is to say about 4,400 people a day[80]. The reformation of the healthcare sector is opening its

[80] Levin D., *Study Links Polluted Air in China to 1.6 Million Deaths a Year*, New York Times, 2015, https://www.nytimes.com/2015/08/14/world/asia/study-links-polluted-air-in-china-to-1-6-million-deaths-a-year.html

access to different social strata and it is creating a system where medical treatments are becoming more affordable assuring therapies that are more efficient. The negligence of health problems causes a series of effects reflected on society also in terms of economic development and this offers a further reason to drive China to reorganization of the healthcare system. The indirect costs caused by the high rate of mortality for pollution related diseases cannot be underestimated because it directly affects productivity of the labour force.

The government raising of consciousness and the transformation of the approach to the environmental issues has led to a complete reorganization of the main assets involved in the economic process. The transformation of the core values of a society gradually changes the principles and conceptions in the mind of people that become more aware and seek for products and services consistent with their interests and necessities. The purchasing habits change too and enterprises must adapt their main features and internal policies to align themselves to the social changes. The main driver of enterprises always was and will always be profit and trying to pursue this aim will lead them to satisfy costumers' changing demand. Timing is fundamental when approaching to a dynamic environment, and obtaining and keeping a position in international market means to understand what are the right investments to sustain in order to offer consumers an added value to products.

In this framework, industries invest in clean energies to show an attitude actively involved in the environmental cause, producing goods and services in compliance with the respect for environment. The concept of corporate social responsibility has entered in China in 2006 along with the reforms of the corporate laws, embedding the definition according to its unique economic situation and business culture. An enterprise adapting its strategic thinking to an ethical use of resources can obtain a competitive advantage in the global marketplace and can help building brand loyalty among consumers. In return, a responsible behaviour will activate a circle that will push government and

institutions to work for the improvement of the overall system and it will attract the attention of shareholders and stakeholders wanting to sustain the business.

The establishment of a reliable relationship between providers and users of goods and services, including industries and end-consumers, is a key factor to assure the development of the enterprise and can contribute to the improvement of the image perceived from the external environment. The appeal of the firm is decisive when coming to investing decisions because investors, just like any member of the society, are influenced by the social changes and tend to sustain companies that comply with the norms of the society. This will launch a process that is crucial for the growth and the enlargement of the size of business, contributing to the enterprise's success or failure. In general, investors dealing with the decision of sustaining a business will consider the risks related to the investment that, beyond other factors, is determined looking at the firm market capitalization. The market capitalization is represented by the "total dollar market value of a company's outstanding share"[81] and informs investors about its size, which is normally considered a determinant to assess risk.

The clear disclosure of information about the company's activities and the impact that those activities have on the environment is another key element for success. Consumers, or stakeholders in general, ask for reliable data about the outcomes of the business performance to determine their perception about an enterprise. However, China still lacks of an efficient system that regulates the quality of information disclosed and moreover still needs to structure a regulatory system to punish who is responsible for violations that, this way, is not concerned about the consequences of his actions and keep on producing according to his standard activities.

[81] *Market Capitalization*, https://www.investopedia.com/terms/m/marketcapitalization.asp

To sum up, in order to understand how China intends to take advantage of the investments in renewable energies it is possible to analyse the situation from two main points of view: the positive impact on society and environment and the expected benefits on economy. As already said, if society can live in a safe and healthy environment it will participate to the development of the country through the creation of a dynamic system of which education and progress will become the engine. For what concern the second aspect, instead, the mechanism activated by such investment will result in the creation of a competitive advantage of enterprises in a market always more sensitive to climate change issues. In this case, society changes in behaviour will affect the way of doing business of enterprises, causing in turn further changes. This system involves many actors and sees at its centre a firm in relation to the inputs coming from the government policies, the consumers' needs, suppliers' requests, investors and so on. These needs must be endorsed, otherwise the company will be excluded from the market.

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