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China on the Verge of Becoming a Low-Carbon Economy? Outlook on Chinese Green Finance and Sustainable Venture Capital Investments

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List of Abbreviations

BRI ..... *Belt and Road Initiative*
CBIRC ..... *China Banking and Insurance Regulatory Commission*
CBRC ..... *China Banking Regulatory Commission*
CCP ..... *Chinese Communist Party*
CCS ..... *Carbon Capture and Storage*
CDB ..... *China Development Bank*
COP ..... *Conference of the Parties*
CPES ..... *Cadre Performance Evaluation System*
DDPP ..... *Deep Decarbonization Pathways Project*
EES ..... *Economic, Environmental, and Social*
EPB ..... *Environment Protection Bureaus*
ESG ..... *Environment, Social, and Governance*
EV ..... *Electric Vehicle*
FDI ..... *Foreign Direct Investment*
FYP ..... *Five-Year Plan*
GCG ..... *Green Credit Guidelines*
GHG ..... *Greenhouse Gases*
GRI ..... *Global Reporting Initiative*
GVC ..... *Governmental Venture Capital*
INDC ..... *Intended Nationally Determined Contribution*
IPO ..... *Initial Public Offering*
IRENA ..... *International Renewable Energy Agency*
IVC ..... *Independent Venture Capital*
KPI ..... *Key Performance Indicators*
MEE ..... *Ministry of Ecology and Environment*
MOHURD ..... *Ministry of Housing and Urban Rural Development*
NDC ..... *Nationally Determined Contribution*
NDRC ..... *National Development and Reform Commission*
PBOC ..... *People's Bank of China*
PRI ..... *Principles for Responsible Investments*
R&D ..... *Research & Development*
RE ..... *Renewable Energy*
SME ..... *Small and Medium-sized Enterprise*
SOE ..... *State-owned Enterprise*
UN ..... *United Nations*
UNFCCC ..... *United Nations Framework Convention on Climate Change*
VC ..... *Venture Capital*

1. Introduction

August 2nd marks the Earth Overshoot Day in 2023. As the crisis becomes apparent in all parts of the globe, China has found itself on the wrong end of the blame game for climate change. In recent years, the altruistic abandonment of energy sourcing, such as fracking in the United States or the radical withdrawal of nuclear energy in Germany, has initiated public discourse about the role individual nations play in meeting the declared goals of the 2015 Paris Agreement. Meanwhile, the world was dominated by oil, and China's energy consumption structure has primarily been oriented around coal, an energy source far "dirtier" in terms of CO_2 emissions. Since the introduction of the 11th Five-Year Plan (FYP) in 2006, China has managed to shift its energy consumption patterns into a greener direction. This, on paper, has nurtured the narrative of a Green China, at least in the eyes of Chinese officials. As Green Development has for long been politically hot but commercially cold, these efforts are applaudable; however, China is still responsible for about 33% of global CO_2 emissions (EDGAR 2023) and struggles to shed its bad reputation in climate matters. Regarding this matter, Xi Jinping has realized potential not only for an improvement in domestic public perception but also for economic return if China forefronts developments and innovations in the field of sustainability.

While it has mainly been advancements in technology that caused this point of ecological atrophy, it is also technology, alongside societal changes in behavior, that is needed to achieve the threshold of carbon neutrality by 2050, as declared by the United Nations (UN) in the Paris Agreement 2015. As Azevedo et al. (2020) described, reshaping the global economy into a more sustainable common ground, also known as "deep carbonization," will require severe efforts across all industries. The unwillingness of corporations to adhere to ecological standards, highlighted by notorious manipulation scandals such as the 2015 Volkswagen Diesel Emissions Scandal, the 1989 Exxon Valdez Oil Spill, or the ongoing illegal logging in the Yunnan Province, signal that audited state intervention and oversight needs to be further strengthened. The Chinese government recognized this need for state intervention and introduced a wide range of substitutes and regulations to address it. These measures have led China to become one of the leading forces in Green Finance, particularly in Green Bonds, where it represents the world's largest issuer. Large-scale projects such as the Belt and Road

Initiative (BRI) or emerging innovations receive generous funding from the state-owned China Development Bank (CDB) with the clear target of also promoting sustainability.

1.1 Approach

Due to the overwhelmingly large nature of topics in the family tree of "*Sustainability*" or "*ESG*," this study ultimately focuses on improving the understanding of China's Low-Carbon Economy ambitions. It does so by means of providing a comprehensive literature review of the impact that Green Finance has in reducing carbon emissions, which advancements were made for the region of Mainland China in the finance industry, as well as a look into the particular role venture capital takes in the matter.

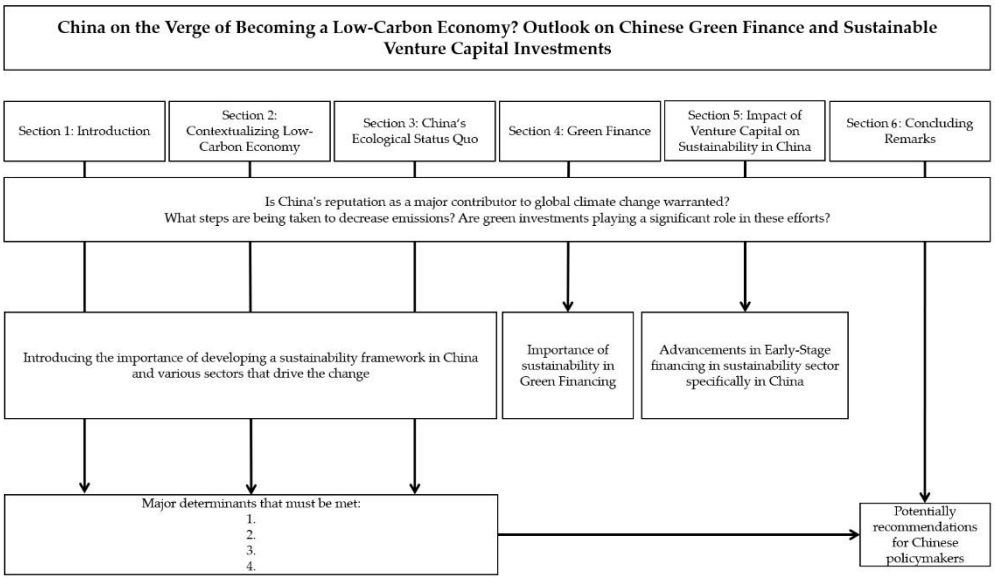


Figure 1: *Conceptual Framework*

First, an overview will be provided that assesses recent developments and significant agreements as well as an introduction to Low-Carbon Economies. Secondly, the historical timeline will be drawn to better understand China's prevailing ecological situation. In the same breath, since the Chinese government is notorious for its strategic planning, in line with a state-directed economy, future programs are being assessed. The economics part of this paper will be introduced by curtailing the term Green Finance and presenting its intricacies for the Chinese market. The Chinese taxonomy will then be evaluated through the lens of (sustainable) venture capital financing, its differences to other markets, and the state of Green Innovation in China. This study is meant to conclude by briefly summarizing the presented concepts and developments and recommending specific outlooks for further research.

1.2 Relevance

The financial crisis of 2008 and the ongoing, pervasive climate crisis revealed the strong symmetries between systemic crises of economic and climatic nature. These symmetries can be highlighted when comparing similar phenomena:

a. non-sustainable management of resources due to short-term profit-oriented focus (Derivatives – Coal energy),
b. the lack of awareness of external costs and the abolition of responsibilities for consequences the general public has to pay for,
c. the urban sprawl and the housing bubble. (O'toole 2022)

Considering the worsening state of the environment, preventing a further escalation of the climate crisis by promoting technological innovation that addresses environmental concerns seems especially urgent. According to the economic modeling theory, said innovation is widely agreed upon to follow extensive research and development (R&D) investments. R&D activities are cost-intensive and, therefore, more difficult to pursue in competitive marketplaces (Nelson 1959). Regarding China's position, it has now been front-running for ten years, with global fossil CO_2 emissions at a rate twice as high as that of the United States, which is ranked second. If China realizes its responsibility, the likelihood of staying below 2°C is estimated to increase by 20-30% (Kriegler et al. 2015). The 2009 Conference of the Parties (COP) 15 has shown that power demands and economy play as much a factor as emission reduction for the two largest emitters, i.e., the United States and China. For this reason, it is vital to form a regulatory environment in which climate mitigation is feasible and perhaps even lucrative from a financing perspective.

2. Contextualizing Low-Carbon Economy

Low-Carbon Economy refers to an ecological economy that relies on minimal energy consumption and pollution (Chen and Wang 2017). Unlike other concepts that address climate change, it can be seen more as a goal that needs to be reached within a specific time frame rather than other concepts such as bio-economy or circular economy that describe a particular solution. These concepts comprise direct strategies and measures that are meant to achieve the goal of emission reduction. As an illustration, the European Commission has presented an objective to establish an economy with low-carbon emissions by 2050, where the bio-economy is anticipated to have a noteworthy contribution (Suttie et al. 2017).

The concept was first introduced in a white paper called "*Our energy future – creating a low carbon economy*" in 2003 by former British prime minister Tony Blair (Chen and Wang 2017). While decarbonization will likely have to happen in every sector, the solutions need to be evaluated on a case-by-case basis. Incentivizing producers and consumers toward low-carbon solutions can be achieved by stakeholder pressure, which is already happening in many consumer markets. Still, the single most effective tool in every market-based economy is the pricing mechanism (Extantia 2022). Such pricing mechanisms can happen in domestic markets, but their effect increases drastically if pursued internationally in Unions or treaties. Individual projects like the *Net-Zero America Project* by the Princeton University on a local level or the Deep Decarbonization Pathways Project (DDPP) with a global scope, initiated by the UN, are examples of how engagement is happening on different layers of institutes (Allan et al. 2023).

According to many, the deciding factor toward a low-carbon global economy is that the largest emitters take immediate action. The five largest emitters of CO_2 in the world, namely China, USA, India, Russia, and Japan, account for over 60% of the world's total emissions. With over 32%, China leads this infamous ranking by a wide margin (Fominova 2022b). This leads many to conclude that these countries live at the ecological expense of others and that from these big players, there is too little development toward becoming low-carbon economies. However, as mentioned, it is advisable to look closely into individual sectors to see whether sufficient progress is happening.

2.1 Sustainability

Definitions of the term *sustainability* are numerous, without there being one on which scholars have universally agreed upon, which would be applicable in all situations. Ehrenfeld described sustainability as "*the possibility that humans and other forms of life will flourish on the planet forever*" (Rosen 2020). Since this definition has only limited practical application, Meadowcroft provided a more precise alternative:

"*Sustainability, the long-term viability of a community, set of social institutions, or societal practice. In general, sustainability is understood as a form of intergenerational ethics in which the environmental and economic actions taken by present persons do not diminish the opportunities of future persons to enjoy similar levels of wealth, utility, or welfare*" (Meadowcroft 2019).

Building upon this foundational understanding, recent years have witnessed a pivotal shift toward establishing a comprehensive framework known as Economic, Environmental, and Social Sustainability (EES). This approach has received global recognition, particularly in conjunction with the rising significance of Environment, Social, and Governance (ESG) (Alsayegh et al. 2020). Illustrated in Fig. 2, the sustainability theory displays the trilemma of the three categories that can be affected by developments in sustainability matters around EES.

Figure 2: *Sustainability Theory (Donnanuragica 2023)*

2.1.1 Economic Sustainability

Unlike economic growth, which can easily be confused with economic sustainability, economic sustainability is not purely measured in generating sales and profit or, from a macro perspective, predominantly quantified in GDP. The focus here lies more on guaranteeing economic development without abating economic growth. Depending on the development of a nation, there is a varying emphasis on development and growth. Generally speaking, the more advanced an economy is, the more it benefits from development rather than growth (Building Sustainable Cities 2020).

Doane and MacGillivray describe it as "*the business of staying in business*"; however, they argue that economic sustainability is "*the most elusive component of the triple bottom line approach which includes economic, social and environmental sustainability*" (Doane and MacGillivray 2001).

2.1.2 Environmental Sustainability

The sustainability theory suggests that environmental sustainability is the most essential dimension among the three (Sander et al. 2021). It is also the one most people think of when hearing the word *sustainability*. Wildflower and Brennan (2011) argue that it in fact lays the foundation for all other sustainability areas. Therefore, social and economic sustainability are seen as derivatives of environmental sustainability. They argue that three aspects should be taken into consideration: Economy is integrated and supported by nature and must be treated as such; resources flow within a system and need to be reused instead of a linear, unsustainable flow of resources; environmental thinking is to think long-term instead of short-term (Wildflower and Brennan 2011).

2.1.3 Social Sustainability

Societal sustainability is a concept that emphasizes the quality of life and well-being in a society. The conceptual framework is widely known to be consistently under construction, which also lies in the nature of society in general since values and norms are constantly subject to change within generations (Eizenberg and Jabareen 2017).

Mckenzie understands social sustainability to be a "*life-enhancing condition within communities*" that matches seven selected criteria, some of which are widespread political participation of citizens, particularly at a local level; equity between generations; equity of access to key services (including health, education, transport, etc.); a system of cultural relations in which the positive aspects of disparate cultures are valued and others (Encyclopedia of Quality of

Life and Well-Being Research 2014). This focus on equity, health, and cultural development can be found in most definitions of social sustainability (Building Sustainable Cities 2020). Hence, it represents a reasonably comprehensive median of other explanations of the term.

2.2 Sustainability vs. ESG

Sustainability and *ESG* are often used interchangeably. Their differences lie in the point of perspective. Clarifying the individual use case is essential for decision-makers implementing the two concepts in their compliance, mission statements, and other governance tools.

Sustainability	**ESG**
Inside-out perspective	Outside-in perspective
Creating **system value**, which lays the foundation for ongoing enterprise or portfolio value	Increasing **enterprise or portfolio value**, regardless of the impact on the overall system
"How do I impact the world?"	*"How does the world impact me?"*

(Harwood 2023)

It becomes clear that for companies that are, in most cases, shareholder profit-oriented, ESG is the more suitable concept. Meanwhile, regulators are more incentivized to consider sustainability as their overarching target. Since concepts on their own are generally not seizable, regulators and industry leaders worldwide have made efforts to promote actionable targets and legally binding contracts.

In the case of ESG, for example, this mainly happened through ratings and certifications that vary across industries. This way, ESG performance can be expressed quantitatively and qualitatively. Meeting specific criteria can furthermore be rewarded with inclusion in ESG funds (KnowESG 2023). ESG funds under asset management have seen a rapid increase in demand, particularly amongst consumers aged 40 and below, with allocated assets worth 403 billion US$ in 2022, compared to 5 billion US$ in 2006 and an increase of more than 800% in the last five years (Statista 2023c).

Agreements and protocols regarding sustainability have been less industry-specific and more punctuated than for ESG. The first notable and legally binding was the Kyoto Protocol in 1997.

Recently, the Paris Climate Agreement in 2015 has had the most significant impact, along with the yearly organized UN Conference of the Parties (Maizland 2020).

2.3 Kyoto Protocol

The Kyoto Protocol, a pivotal development in the global effort to address climate change, emerged as a direct response to the concerns articulated by the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The UNFCCC set the stage for international discussions on the impact and prevention of global warming, though it faced criticism for lacking specific emission targets and timetables (Cooper 1999). Over a decade later, in an effort to rectify these shortcomings and establish a more robust framework, the Kyoto Protocol came into existence. This protocol not only marked a historic milestone by legally obligating its members to enhance domestic sustainability domains but also garnered widespread international support. With over 170 countries participating in the negotiations, including representatives from diverse groups such as OECD nations, OPEC oil-exporting countries, Russia, and most developing countries, the Kyoto Protocol achieved uniform acceptance. Notably, it addressed the concerns raised by the UNFCCC. It sought to curb emissions globally, even as the United States, at the time the largest emitter of CO_2 and Greenhouse Gases (GHG), grappled with its role in the international environmental landscape (Cooper 1999).

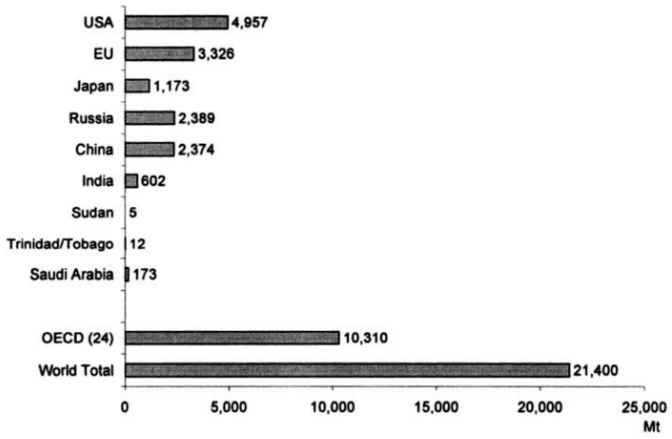


Figure 3: *Total CO_2 Emissions of Selected Players in 1990 (Cooper 1999)*

U.S. President Bush declined to sign the protocol and was very skeptical about the severity of the environmental issue. Despite public pressure to undertake climate action and severely influenced elements in the final agreement, the US did not ratify the protocol (Hovi et al. 2012).

Bush's inert stance was criticized by Al Gore in 1991 as "the single worst abdication of leadership ever" (Oberthur and Pallemaerts 2010).

Perhaps the biggest point of discussion at the time was the role of developing countries such as China, India, and others from the G77. Due to its already prospectively large industry, the bloc was called "*G77 plus China*". The G77 plus China were not obligated to reduce emissions; they only had to improve sustainable development and increase reporting standards. Especially China's unwillingness to be treated as a special case, *too big for developing and too small for developed*, created discontent on the side of the US. However, since the emissions of the US, particularly per capita, were much larger, as seen in Fig. 3, China's veto on special treatment was granted (Finamore 2018).

2.4 Paris Climate Agreement

After unsuccessful and uniformly disappointing results of the COP15 in Copenhagen in 2009, an international consensus on climate matters did not appear to exist. Especially the US and China, increasingly converging in economic metrics, refused to make concessions. A major turning point in discussions appeared when then-U.S. President Obama and Chinese President Xi Jinping in 2014 set the stage for a more cooperative approach (Swaine 2017). The United States committed to reducing their GHG emissions by 26-28% below 2005 levels by 2025, while China pledged to peak its CO_2 emissions around 2030 and increase the share of non-fossil energy in its primary energy consumption to around 20% (Liu et al. 2023). This collaborative effort between the two largest GHG emitters laid the groundwork for broader international cooperation.

The Paris Climate Agreement, signed in 2015 by 195 countries, aimed to limit global temperature increases to well below 2 °C above pre-industrial levels, with efforts to pursue a more ambitious target of 1,5 °C (UN 2023). Essential elements of the Agreement comprise:

- *Long-term temperature goal* (Art. 2) – Accentuation on the goal of limiting global temperature increase below 2 °C with the target of staying below 1.5 °C
- *Global peaking* (Art. 3) – With the target of a sub 1.5 °C temperature increase, all parties are required to peak their GHG emissions as soon as possible. Hereby, for developing country parties, a longer period is expected and, therefore, accepted.
- *Mitigation* (Art. 4) – Each party is obligated to prepare and legally commit a nationally determined contribution (NDC) every five years. Each NDC must reflect a progression

of its predecessor. Standards for NDCs vary between developing and developed countries, meaning more mitigation emphasis for developing and more leadership-oriented absolute reduction targets for developed countries.

- *Market and non-markets* (Art. 6) – The Paris Agreement introduces a mechanism for market approaches to mitigate GHG and defines a framework for non-market approaches.
- *Loss and damage* (Art. 8) – Further enhancement of the Warsaw Mechanism of Loss and Damage, which supports vulnerable countries to cope with the effects of climate change.
- *Support* (Art. 9, 10, and 11) Commitment to supporting climate action by mobilizing financial resources, facilitating technology development and transfer, and enhancing capacity building, with a focus on fostering innovation for both mitigation and adaption efforts, particularly in developing countries
- *Transparency* (Art. 13) – Transparent accounting system that works as foundation for trust and accountability for all parties. Each nation has to annually report internationally peer-reviewed information on their efforts.

(UNECE 2016)

2.5 Measurements and Key Drivers for Low-Carbon Economy

In order to promote low-carbon growth within an economy or to promote the transition toward it, there needs to be a way to measure ecological developments. For this cause, the Chinese -/ and other governments have relied upon the STIRPAT model to track the development of a low-carbon economy. This model, while being used by many countries and researchers, cannot accurately analyze ecological scenarios to an infallible degree. Still, it has proven to be an effective tool, particularly for large-scale regional perspectives (Fu et al. 2015).

Studies applying the STIRPAT model assembled in China between 1996 and 2016 showed that urbanization, secondary industry, and GDP per capita are positively correlated with increasing carbon emissions and that technological progress reduces emissions. A study performed by 22 OECD countries between 1960 and 2007 confirmed these findings (Liddle 2011). The variables of a STIRPAT model are slightly subject to change. Still, they generally follow the logic of comparing population, affluential data, and technological development through the lens of environmental impact. Fig. 4 shows the parameters of a STIRPAT model

used by Fu et al. (2015) for the Chinese town of Wanquan in 2015. The formula is written in logarithmic form as follows: $I = aP1^b P2^c A^d T^e S2^f S3^g h$

Parameter	Symbol	Definition	Unit
CO_2 emissions	I	Energy-related CO_2 emissions	t CO_2
Population	P1	Total population	10^4 people
Urbanization level	P2	Urban population proportion of the total population	%
GDP per capita	A	GDP per capita	10^4 Yuan per capita
Industry energy consumption intensity	T	Industry energy consumption per unit of GDP	tce/10^4 Yuan
Secondary industry proportion	S1	The proportion of the value of the secondary industry to the GDP	%
Tertiary industry proportion	S2	The proportion of the value of the tertiary industry to the GDP	%

Figure 4: *Sample Parameters for STIRPAT Model (Fu et al. 2015)*

Apart from the macro perspective that the STIRPAT model provides, there are sector-specific measurements that allow for an in-depth analysis of micro factors.

The European Commission, for example, uses as one measure to assess the EU's progress toward a Low-Carbon Economy by summing up the total expenditures in Low-Carbon Economy projects. These are aggregated into six different special-purpose funds (status: 2020). These are: *The Cohesion Fund*, *European Regional Development Fund*, *European Agricultural Fund for Rural Development*, *European Maritime and Fisheries Fund*, *European Social Fund, and Youth Employment Initiative*. Therefore, the total yearly funding of those funds represents the EU's respective measurement for developing a Low-Carbon Economy (European Commission 2020).

Some countries have followed recent studies that indicate economic development and performance directly correlate to an economy's efficiency. Subsequently, the same logic that works for a classic economy can also be applied to a low-carbon economy, meaning when

rating the performance of a low-carbon economy, it is helpful to analyze its efficiency (Liu and Liu 2016).

Liu and Liu have drawn an analysis of 20 countries on the efficiency of their economies for the period 2000-2012. For the purpose of this study, the development of the G8 (with the EU being replaced by China and India) can be seen in Figure 5 below.

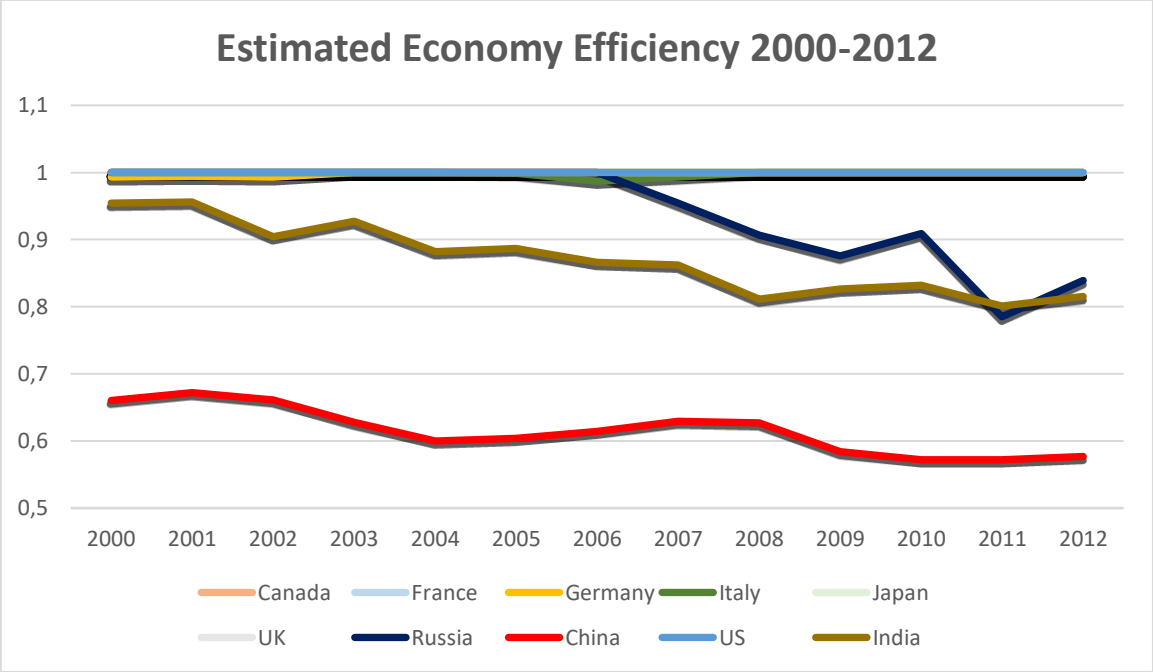


Figure 5: *Estimated Economy Efficiency 2000-2012 (Liu and Liu 2016)*

The analysis of Liu and Liu (2016), comparable to the STIRPAT model, takes into account energy consumption and emission output in relation to affluential and social factors, such as GDP, GDP per capita, governmental support, import and export quota, capital stock, labor force or urbanization rate. With a score of 1.0, representing an efficient economy, most Western countries of this period received an ideal score. Inefficiencies were found mainly in developing countries with high population density and high coal energy consumption patterns. For better interpretation, an updated version of this study, particularly after the increased efforts following the Paris Climate Agreement 2015, would be of great interest to further studies.

Figure 6 by Hristov and Chirico (2019) demonstrates how a sustainable strategy can be integrated on a corporate level by formulating a set of achievable key performance indicators (KPI) with benevolent goals.

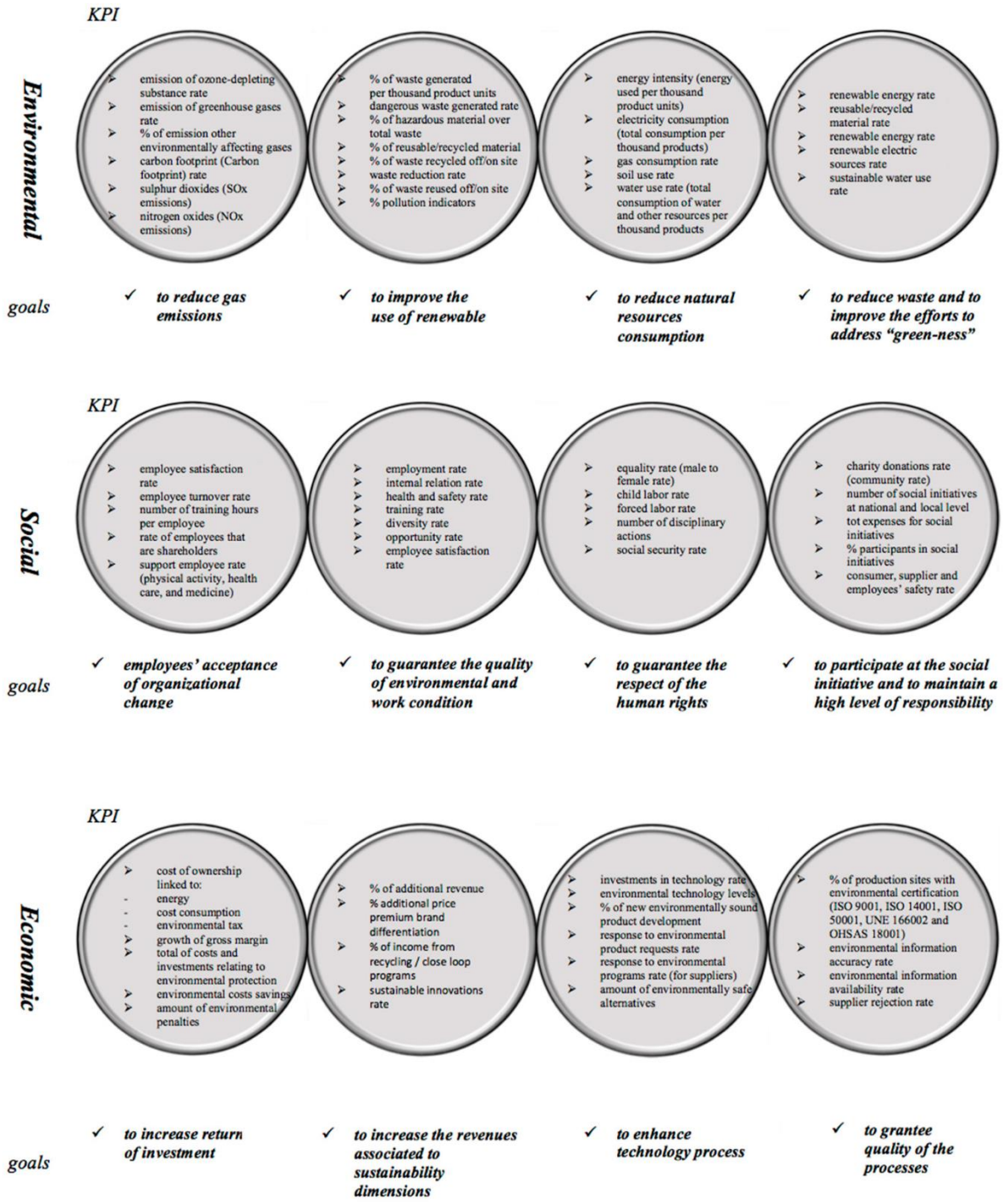


Figure 6: *Sustainability Performance Indicators (Hristov and Chirico 2019)*

2.6 Harmonious Effects of Climate Change and Innovation Technology

As mentioned in the introduction, innovation is a double-edged sword. Proponents and technocrats eagerly await scientific breakthroughs such as Carbon Capture and Storage (CCS) or commercially viable nuclear-fusion power plants, which would instantaneously solve human power demands in a low-carbon manner. Still, they are not expected to be available before 2050 (Lüthje et al. 2011). Critics, on the other hand, argue that while innovation will

play a major role in decarbonization, it will not be fast enough and call for transdisciplinary solutions such as behavioral change and strict policies (Matos et al. 2022).

Du et al. (2019) discuss in their patent analysis if development in Green Technology Innovation actually has an effect on emission mitigation. Their research illustrates a positive correlation between Green Innovation and carbon reduction. However, this effect is tied to the respective economy's income level. High-income countries displayed significantly better capability to build and implement low-carbon technology. These findings are interesting from two perspectives. First, they explain the recent increase in Low-Carbon Chinese budget spending synchronous to a significant increase in income per capita for China (Statista 2023d; BloombergNEF 2022). Secondly, the data underlines that Green Technology is expensive and, therefore, highlights the importance of supportive governmental structures for low-carbon transition employing Green Finance, particularly for low-income countries.

Innovations addressing climate change are labeled as "*climate change mitigation technology*", "*climate technovation*", "*low-carbon transition technology*", "*low-carbon innovation*", or other related terms. Regardless of their title, they can all be categorized into four areas:

a) *Improvement in energy efficiency*
b) *Renewable energy*
c) *Nuclear energy*
d) *Carbon capture storage*

(Wilson Nwankwo et al. 2020). These four broad areas comprise the most promising and relevant drivers for the low-carbon transition. Technology in this field also tends to create network effects within itself; for example, the implementation of smart grid projects (a) for electric vehicles (EV) focusing on utilization demand and renewable energy supply (b) has shown to increase demand for both of these innovations (Sultan et al. 2022).

3. China's Ecological Status Quo

China's rise as an economic superpower since the late part of the 20th century has been remarkable. "*The China Miracle*", as it is named by the OECD (Yifu Lin 2004), has been made possible by a number of factors. Intensive Foreign Direct Investments (FDI) assisted by Deng Xiaoping's reforms for Special Economic Zones, technological transfer, innovation, and pragmatic policymaking that enabled fast-paced growth are just a few of the factors that significantly impacted China's upbringing. However, one factor that cannot be neglected, perhaps the most prominent one, is the unprecedented increase in coal consumption. One possible explanation for this phenomenon is the Pollution Haven Hypothesis. According to this theory, the varying levels of environmental regulation in developed and developing nations create a situation in which developing countries have an advantage in pollution-heavy industries (Bogmans and Withagen 2010). Carbon-intensive fossil fuel has powered Chinese economic activity for many years. This has resulted in China consecutively being the largest coal producer from 1992 until 2023. To this day, China alone produces more coal on its own than the following ten largest coal-producing countries combined (Worldometer 2023). Confronting this issue has been one of the top priorities of Chinese officials in the past 15 years and, therefore, received much more attention in the FYPs.

To address climate change, the Chinese Communist Party (CCP) mainly applies three different tools:

- *Target-setting*

Target-setting plays a pivotal role in the Chinese state bureaucracy, particularly in the evaluation process for cadres. This practice of target-setting dates back to the Mao era of planned economy, where production targets played an even more impactful role than nowadays. Until recently, GDP growth was paramount to all other criteria on cadre promotion decisions. Following global climate debates in the 2000s and 2010s, the Central Government moved to a Green GDP and more sustainable factors to evaluate regional development in 2017 (Qi et al. 2020). Another significant case for target-setting is China's FYPs, in which economic and social targets are decided and evaluated on a five-year basis. Some of the targets are

binding, others are not. Those that are not binding are usually documented for signaling purposes (Carbon Brief 2021).

- *Behavior modification*

As China enters an era of coercion in the name of ecological sustainability, social costs are mounting. To minimize these costs, the Chinese State has increased efforts to change its citizens' behavior in a more sustainable direction. In 2018 China's Ministry of Ecology and Environment introduced the "*Citizen Ecological Environmental Behavioral Code of Conduct*" 公民生态环境行为 (*Gōngmín shēngtài huánjìng xíngwéi*) (Mee 2018). The document describes unwanted civil behavior ranging from littering to energy waste. In a follow-up document released in October 2019, the National Development and Reform Commission published a paper called "Overall Action Plan for Launching Green Living" 绿色生活创建行动总体方案 (*Lǜsè shēnghuó chuàngjiàn xíngdòng zǒngtǐ fāng'àn*) that doubled down on promoting desired societal behavior (NDRC 2019). These desired conducts can be expected to be integrated into the rumored Chinese Social Credit System. In a trial run in the village *Yángdé* 阳德, virtuous deeds such as recycling or other eco-friendly habits were rewarded with credit points in a so-called *morality bank* (Li and Shapiro 2020).

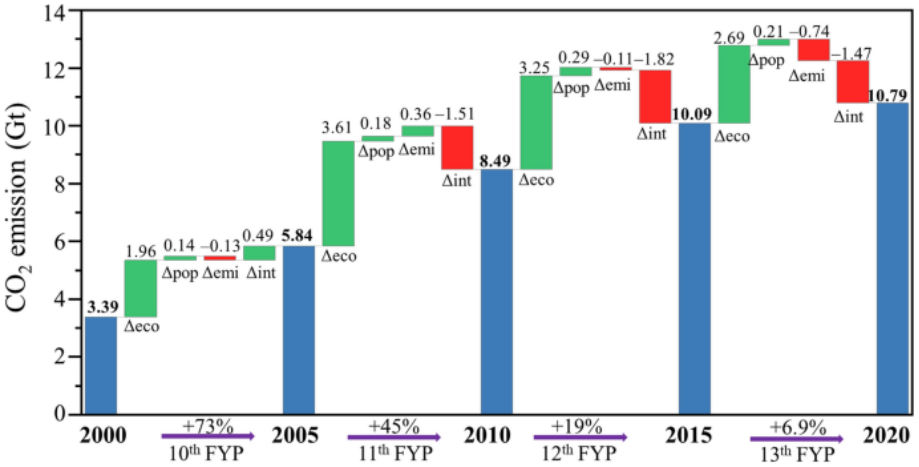
- *Campaigns*

Political campaigns 运动 (*Yùndòng*) in China have a rich history that dates back many centuries. They were intended to achieve a specific set of goals within a short time. China's more prevalent, although infamous, campaigns happened in the 20th Century under Mao Zedong (Li and Shapiro 2020). Deng Xiaoping, as the paramount leader after Mao, was also appreciative of the power large-scale campaigns possessed. With its "*One-child Policy*", introduced in 1979, the Chinese government addressed not only the issue of poverty alleviation but also, probably inadvertently, ecological control by equilibrating population size (Kane and Choi 1999). Nowadays, the one-child policy has been abandoned, but it was the predecessor for many other, more direct toward environmental-governance oriented policies. Under the former General Secretary of the CCP, Hu Jintao, campaigns related to ecological topics were primarily opportunistic, like the "*Blue Skies for Beijing*" campaign as part of the Beijing Olympic Games 2008 (McLeod et al. 2018). Around the same time, he also introduced the present idea of China as an ecological civilization 生态文明 (*Shēngtài wénmíng*) that Xi Jinping further developed into the Party's ideology by referring to an old saying: "*Clear waters,*

green mountains are in fact gold mountains, silver mountains" 綠水青山就是金山银山 (*Lǜ shuǐ qīngshān jiùshì jīnshān yín shān*) (China Media Project 2023).

3.1 Emissions Catalogue by Sector

Emissions:



Development of China's CO_2 emissions across the FYPs from 2000 to 2020. Red signifies negative and Green positive contribution. Emission changes are fragmented into changes in contribution from population (ΔC_{pop}), economic growth (ΔC_{eco}), energy intensity (ΔC_{int}), and the emission coefficient (ΔC_{emi})

Figure 7: *Development of CO2 Emissions across the FYP (Wei 2022)*

Figure 7 illustrates China's decreasing emission growth and the strategic goal-setting along the FYPs. The strongest emission increase happened under the 11th and 12th FYP, encompassing China's economy's most substantial growth rates (NBSC 2023). Economic growth was the highest contributor, with a means contribution of 3.43 GT CO_2, followed by population, with a means of 0.195 GT CO_2. Significant improvements were realized in the overall contribution of energy intensity, which decreased by a means of 1.49 GT CO_2 per FYP. While this is a positive development, the trend in energy intensity contribution is expected to shift toward an increase during the 14th FYP as a reaction to the COVID-19 pandemic and increased energy prices (Finamore 2018).

By 2020, China's leading drivers of GHG emissions were electricity and heat, manufacturing and construction, and the industry (Fig. 8). All of those are resource-heavy sectors and are characterized by great energy demand. China soon recognized this issue and invested heavily in renewable energy sources. Renewable energy production accounted for 27.32% in 2020, as opposed to 17.03% in 2000 (Statista 2023e). Our World in Data also indicates that China's emissions peaked in 2020 with an upward trend, representing 30% of the global total emissions. Critics argue that more than one-third of China's emissions might result from the production of exported goods, which would massively dilute data on China's emissions (Sun and Ren 2021). China's energy intensity (*energy consumption per unit of GDP*) remained

relatively stable despite efforts in the *Made in China 2025* agenda and clearly defined targets to transition from a manufacturing to a service and innovation economy (Fig. 10 & (Liyu Zeng et al. 2023)). The carbon intensity (*carbon emitted per unit of energy produced)* during the period from 2000 to 2020 has been reduced by about 10%. However, this reduction can be attributed to the increase in renewable energy production and not to decreased coal or gas consumption. Figure 9 shows that following China's 2015 NDCs, consumption of emission-heavy sources of energy had been reduced, perhaps also to shrug off China's old title as "*king coal*", but supply shortages and the global trade war with the US forced previously closed Chinese coal plants to reopen (Feng 2019).

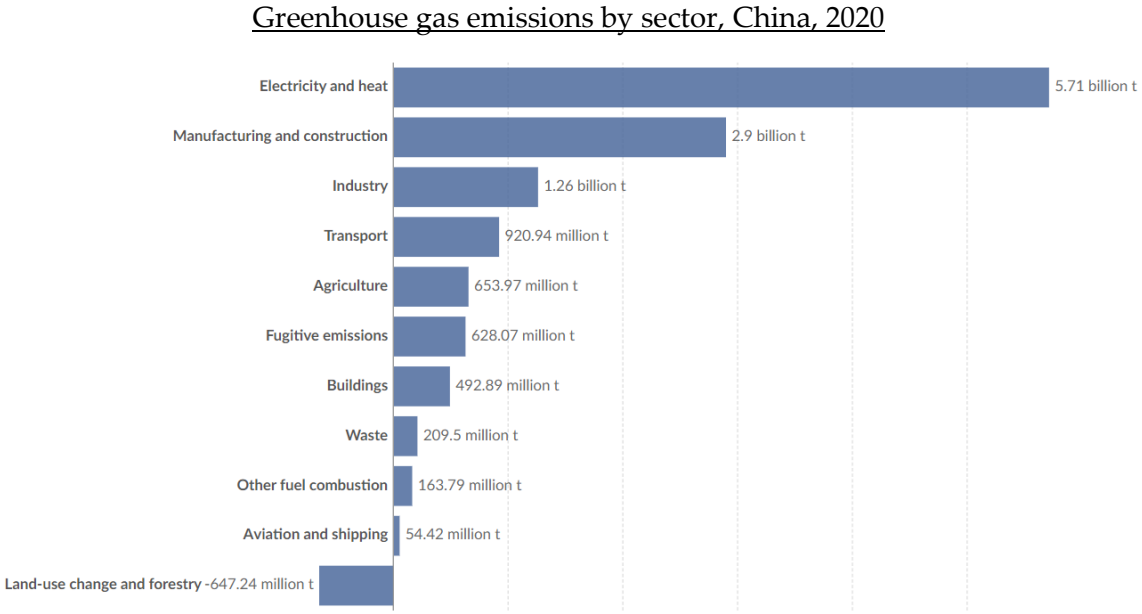


Figure 8: *Greenhouse Gas Emissions by Sector, China, 2020 (Our World in Data 2023c)*

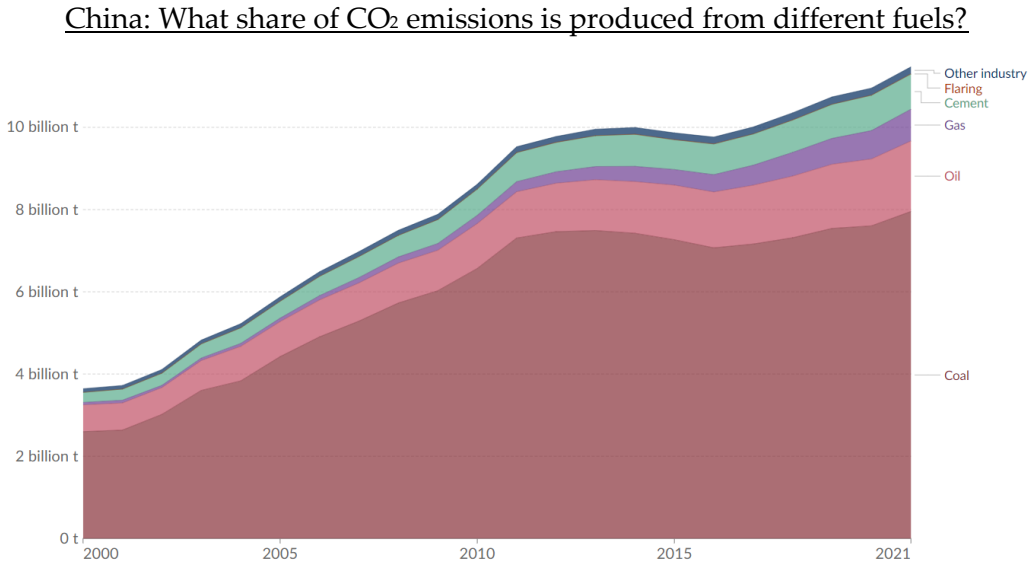


Figure 9: *China: What Share of CO2 Emissions is Produced from Different Fuels? (Our World in Data 2023b)*

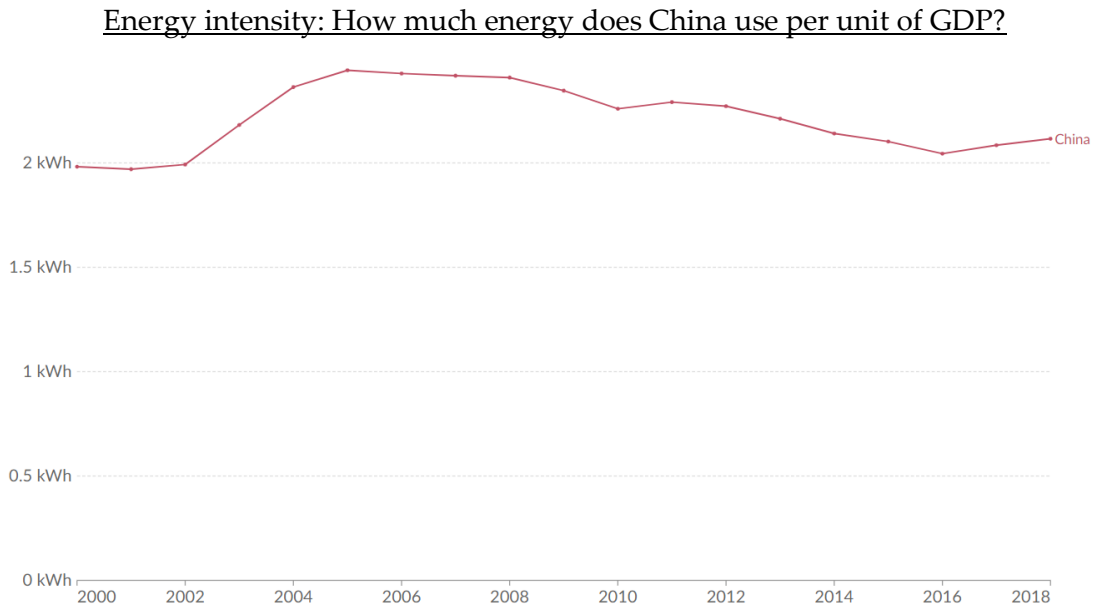


Figure 10: *Energy Intensity: How much Energy does China use per Unit of GDP? (Our World in Data 2023a)*

3.1.1 Policies:

The Climate Action Tracker ranks Chinese policies as highly insufficient and asserts that if those were globally applied policies, the 2°C target would not only be not met, instead it would be likely to reach <4°C global warming. The same verdict applies to the United States and Japan. The EU stands at <3°C and India at <2°C (Herrmann Chen 2021).

Policy Evaluation by Sector				
	Low	**Medium**	**High**	**Frontrunner**
Renewable energy in the power sector			- Target of 25% share of non-fossil fuel primary energy and >1200 GW of solar wind capacity by 2030 - Wind and solar energy set to make up 16.5% of energy mix by 2025	
Coal phase-out in power sector	Dismissal of previously declared coal plant phase-out plans amidst COVID-19 recovery plans		- Binding targets for energy reduction and emission share to GDP	- First country to decouple GDP growth from coal consumption
Phase out fossil fuel cars			- Phasing out of conventional fossil fuel cars by 2035 - EV target sales of 20% by 2025. Set to	

			increase to 50% by 2035	
Phase out fossil fuel heavy-duty vehicles		- Decreased fuel consumption limits for new tractors (15%), trucks (14%), buses (16%) - No plans for further reduction		
Modal shift in (ground) transport		- Three-year plan to reduce diesel-burning and increase electric-powered transport that is yet behind its schedule - Intercity railways planned for metropolitan areas		
Near zero energy new buildings			- 20% target for energy efficiency 2020 - Green Buildings accounting for >50% of new urban buildings	
Energy efficiency in industry			- High degree of mandatory energy efficiency policies for the industrial sector (75%) - Carbon peak targets 2025 for the emission-heavy aluminum industry	
Retrofitting existing buildings		- Guidelines issued through the Ministry of Housing and Urban-Rural Development (MOHURD) to conduct Green Renovation of existing buildings		
Net zero deforestation		- Further expansion of previously ambitious target to increase forest stock by 6 billion instead of 4.5 billion by 2030 compared to 2005 - Stricter policies for afforestation and log importation		

Figure 11: *Policy Evaluation by Sector (Kharas et al. 2022; Climate Transparency 2021; Finamore 2018)*

3.1.2 The Significance of Energy in reaching Carbon Neutrality

Carbon neutrality can be achieved through carbon reduction or through carbon offsetting. Large scale carbon reduction is hereby widely regarded as the more feasible option to reach net-zero goals in time. The largest portion of reducible emissions comes from improving energy sources and energy needs in scope 1 and 2 emissions (Fominova 2022a). In the case of China, the energy sector accounts for almost 90% of GHG emissions, which is why political considerations and entrepreneurial innovation in the energy sector are particularly important (IEA 2021).

3.2 Commitments toward reaching the 2015 Paris Agreement Pledge

During the 2009 UN climate negotiations in Denmark COP15, China had been accused by many participants of having undermined progressive talks, unwilling to forfeit their competitive advantages in emission-heavy, coal fueled industries (Lynas 2009). At the time, it was US President Barack Obama who made efforts to advance the international sustainability agenda, determine a 1.5°C target, and practice environmental leadership.

At the 2015 Paris Agreement it was China who committed, among other duties, to peak its CO_2 emissions by around 2030. They also signed a deal to increase their energy share of non-fossil energy for its primary energy consumption to about 20% by 2030. During the conference, a strong emphasis was put on China's Intended Nationally Determined Contributions (INDC), which comprise many of the in chapter 3.2.1 further explained mentioned 2030 pledges (Gao 2016). Those targets, while very ambitious, were non-binding and, just like their updated version in 2021, are labeled by climate analysts as insufficient for the 2030 emission plans (Climate Action Tracker 2023). China's lead representative of the conference proposed a global governance model based on win-win cooperation that takes all countries' signed assumption that each member has to take responsibility, no matter the size of the respective economy, as a baseline. This, on the one hand, showed China's willingness to cooperate and create an active governance, on the other hand, it could be interpreted as execution of soft power by building environmental alliances (Gao 2016).

3.2.1 China's 2020 Strategy - The 2030 and 2060 Pledge

In chapter 3, we have introduced that 2017 the State Council announced the Green GDP as a more low-carbon friendly means to assess the provincial cardres' performance. This measure was part of the 13th FYP and its subcategory for Protecting the Ecological Environment (Li and

Shapiro 2020). Just three years later, in September 2020, President Xi announced the aim to achieve a carbon peak before 2030 and carbon neutrality before 2060. The total annual investment required for that is estimated at 640 Bil. US$ by 2030, and around 900 Bil. US$ until 2060. The report emphasized the importance of innovation for low-carbon development like EVs or renewable energy solutions (IEA 2021). This aligns well with China's *Made-in-China 2025* strategy, which heavily encouraged Chinese production quality and innovation. It can be seen that the previously mentioned concept of *target-setting* and *campaigns* go hand-in-hand in China's strategic skirmish for environmental sovereignty.

Whether the promises made in September 2020 will be kept remains to be seen, but they were a strong signal to a weakened US that China is willing to assume leadership in clean-tech innovation and the markets of tomorrow. No other country besides Germany invests nearly as much in the clean energy sector as China (Colenbrander et al. 2023). It already holds monopolistic positions in solar panel and hydro-power development and rare earths, and this momentum does not appear to be slowing down anytime soon (Finamore 2018).

3.3 China post COVID-19 – The 14th Five-Year Plan

As the 14th FYP for the years 2021 to 2025 was formulated, its implications on COVID-19 had not been factored in. The pandemic has inflicted great damage on China as a global supply chain, an economy, and as a location in general. Targets made in the 14th FYP, therefore, need to be taken with a grain of salt since China's focus has involuntarily had to shift a bit from its initial plan. On the other side, post-pandemic recovery also presents an opportunity to accelerate the transition toward a low-carbon economy.

One of the main targets of the 14th FYP was to decrease the time until CO_2 peaking. In September 2020, President Xi made historic commitments with his 2060 carbon neutrality pledge (Hepburn et al. 2021). If China can keep its promises to peak by 2025, this will be a strong signal of its global ambitions and demonstrate the fitness of the CCP in delivering actionable results. A recent study by the Tsinghua University indicates that China needs to shift its energy mix to 84% renewables as fast as possible to align with 2060 targets (Bloomberg 2020). Opposing to that stand the dozens of newly-built and scheduled power plants; China's current power-plant schedule equivalates two new coal plants per week. Most of them are located in grid regions with high power-plant density; this contradicts the framing of coal as a supporting energy source for clean energy (The Guardian 2023).

3.3.1 KPIs Defined by the CCP

In its 14th FYP, China set a wide range of goals to strengthen the Chinese economy and society between 2021 and 2025. Goals, and in part also specific KPIs, were placed for the following categories:

- *Economy*
- *Environment*
- *Energy*
- *Transport*
- *Research and Development*
- *Urbanisation*

(Wikipedia 2023)

Declared relevant indicators of the 14th FYP that for Green Development are listed in Figure 13.

Main indicators of Green Development during the 14th FYP period

Category	**Indicator**	**2020**	**2025**	**Annual average/ [cumulative]**	**Nature**
Innovation	Growth in R&D spending	-	-	Growth > 7%. Aim for higher share in GDP than under the 13th FYP (2.2% of GDP)	Indicative
	Number of innovation patents per 10.000 people	6.3	12	-	Indicative
Green Ecology	Reduction in energy consumption	-	-	[13.5]	Binding
	Reduction of carbon dioxide emissions per unit of GDP	-	-	[18]	Binding

	Share of days with good air quality in cities at the prefecture level and above	87	87.5	-	Binding
	Share of surface water at or better than class III	83.4	85	-	Binding
	Forest coverage rate	23.2 (as of 2019)	24.1	-	Binding

Figure 12: *Main Indicators of Green Development during the 14th FYP Period (Carbon Brief 2021)*

Of 119 key projects described in the 14th FYP, 19 touch on innovation and 14 on sustainability subjects, a decrease of 45% and 55%, respectively, compared to the 13th iteration of the FYP (Grünberg and Brussee 2021). This could have multiple reasons, such as the mergers of existing projects or a less centralistic approach to funding projects, and needs to be evaluated in the context of the respective sector in which these projects happen. The most relevant factor for China remains to be energy sourcing since energy consumption by a wide margin accounts for the most CO_2 emissions in China (Carbon Brief 2021). The energy mix does not appear as a KPI in the 14th FYP, but there is an outline of a 13.5% reduction in energy intensity by 2025 and an 18% cut for CO_2 emission intensity in that period. For the energy mix, a separate outline hints that ramping up consumption of renewables to around 20% by 2025 (15.8% in 2020) would be desired; however, since this is not ratified in the FYP, this would need to be reinforced through an NDC (ibid.).

4. Green Finance

As one of the fastest-growing economies, China has been demonstrating a robust top-down investment-led growth model to the world. The central government has a strategic, frequently updated infrastructure plan to support its national economic growth and rapid urbanization. The Communist Party has set high priorities and provided direct investment for building the infrastructure framework, such as China's national road network and high-speed train system. This development has resulted in sustained economic growth and increased international competitiveness. That the growth has, at least partially, been achieved by effective policymaking can be seen in the urbanization rate, which is expected to hit 60% in 2028. This was achieved as a result of years of subsidies and regulations to modernize and improve Chinese cities. The same tool of policymaking will and has now been applied in the push toward becoming a leading force in Green Investments and sustainability innovation (Krosinsky 2023).

In the past, China had a financial system that for the most part ignored the negative relationship between economic development and ecological degradation. In 2017 China left this high-input high-output phase when it entered the stage of high-quality instead of high-speed development (Wang et al. 2023). For this change, President Xi had prepared a transition toward a "*greener*" financial system. A Green financial system, unlike a traditional one, takes relationships between human living conditions and the environment into consideration (Feng et al. 2023). The tools of a Green Financial System involve among others stock market indices, Green Growth funds, climate finance, carbon finance, Green Bonds, Green Credits, and funding for environmentally friendly ventures and projects (PBOC 2016).

4.0.1 Terminological Limitation

"Green Finance is just an euphemism for money that is going to be spent on CapEx and on R&D"
(Michael Sheren 2022)

The concept of Green Finance was first formally proposed by Mark White in 1996 and has then been discussed by other scholars (Wang et al. 2023). It has since been evolving, according to the dynamic nature of the environmental debate. Details on what Green Finance comprises are subject to regional variances, depending on the individual markets. For such, for example, in the EU, the term "*Green Bonds*" is associated with securities funding environmentally friendly projects that follow guidelines set by the European Green Bond Standard. At the same

time, in other regions, like the United States, there is no standardized definition of the term "*Green Bonds*" because there, unlike in the EU, no unified regulatory framework has been put in place so far (European Parliament 2022). For the consistency of this paper, any ambiguity in terminological challenges for the specific iteration of the term "*Green Finance*" has been set aside.

4.0.2 Adverse Welfare Risks

While the prioritization of sustainability and decarbonization in finance can have positive long-term economic effects by creating long-term value for the shareholder (Fatemi and Fooladi 2013), in the short-term, it can also be abused and generally implies more risk than a traditional financial system would. Sustainable finance requires more political commitment and a good will of all involved present and future parties. The most prominent evidence for this is the withdrawal of the Trump administration from the Paris Agreement in 2017. By withdrawing from the agreement, Trump not only targeted short-term decreased domestic energy costs by returning to high-carbon sources such as fracking, he also increased climate mitigation costs for the remaining parties of the contract like the EU and China (Zhang et al. 2017). Events like this highlight the importance of binding commitments, particularly in sustainability matters where impacts can often be hardly measured but may have irreversible effects. Fuest and Meier (2023) describe commitment as one of the main success factors for Green Finance and climate policy.

4.1 Green Taxonomy

Just as the definitions for the term "*Sustainable Finance"* are not fully aligned, so are the perspectives for a Green Chinese Taxonomy not entirely uniform. Chinese officials are working on harmonizing definitions, for example, by working closely with the already further developed Green EU taxonomy. Wang Yao, a prominent professor of Green Finance in China, once stated, "*[…] various departments have standards for Green Agriculture, Green Buildings, and Green Manufacturing and technology, but there is no coordination between them*" (Yao 2018). The legislative framework most frequently referred to as China's taxonomy is the Green Bond catalog published by the POBC in 2015. For reporting forms, performance indicators, and the lending market, the China Banking Regulatory Commission issued the outstanding paper called the Green Credit Guidelines (GCG) (OECD 2020).

Figure X shows how the Green Bond catalog labels projects based on their overall subject in level 1 and then more comprehensively in subsequent levels. This catalog has since been updated; the People's Bank of China (PBOC) released its 2021 version of the same document, which goes further in-depth than the 2015 version (PBOC 2021).

Financial Institutions Green Bond Taxonomy	
Level 1 Category	**Level 2 Category**
Energy savings	Industrial energy savings
	Energy savings – Technology improvement
	Sustainable buildings
	Energy management center
	Urban and rural infrastructure construction with energy-saving efficiency
Pollution prevention and control	Pollution prevention and control
	Environmental restoration project
	Clean utilization of coal
Resource conservation and recycling	Water saving and unconventional water use
	Redevelopment and integrated utilization of tailings and associated mine
	Recycling and utilization of industrial solid wastes, exhaust gas and effluent
	Recycling, processing and utilization of renewable resource
	Remanufacturing of electromechanical products
	Recycling and utilization of biomass resource
Clean transportation	Railway transportation
	Urban rail transportation (light rail)
	Public urban and rural transportation (bus)
	Waterway transportation
	Clean fuel
	New energy automobile

	Internet application on transportation
Clean energy	Wind power generation
	Solar photovoltaic power generation
	Smart Grid and energy internet
	Distributed energy resource
	Social thermal application
	Hydropower generation
	Other new energy application
Ecological protection and climate change adaptation	Natural ecological protection and protective development of tourism resource
	Ecological agriculture, husbandry and fishery
	Forestry development
	Emergency Prevention and Control of disaster

Figure 13: *Financial Institutions Green Bond Taxonomy (PBOC 2015)*

With the goal of a harmonized and institutionally applied Green Taxonomy for China, Christoph Nedopil and Xu Qing from the Green BRI Center drew a scenario (Fig. 14) of how a Chinese Green Taxonomy could look based on the 2015 version of the Green Bond catalog and the 18 declared SDGs (Nedopil et al. 2020b).

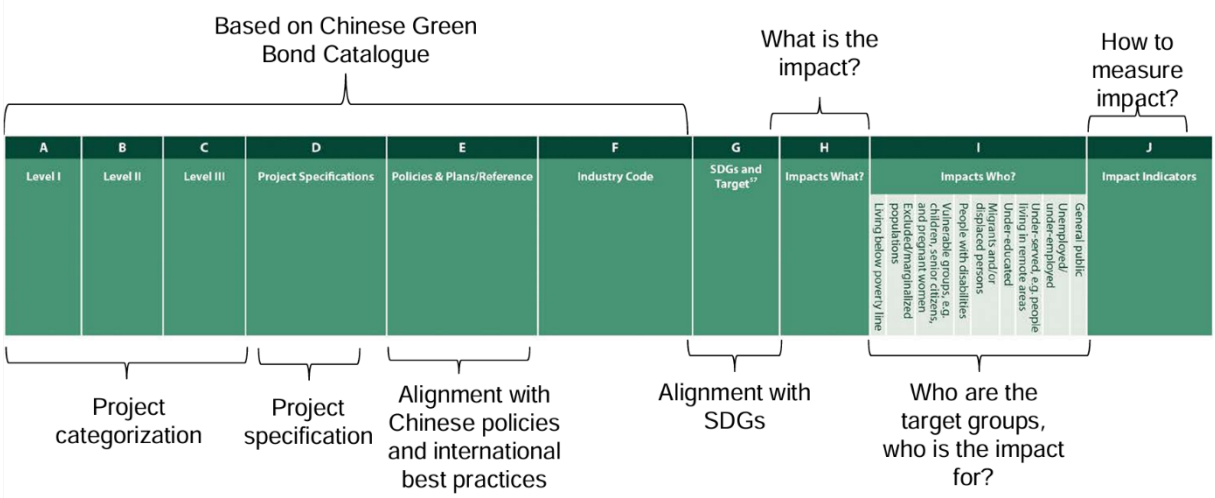


Figure 14: *Example of SDG Finance Taxonomy (Nedopil et al. 2020a)*

4.2 Diversification of Green Financial Instruments in China

4.2.1 Green Bonds

Green Bonds, as a form of ESG investing, have recently seen a rapid increase in popularity. Being reasonably unpopular in the early 2000s, Green Bonds have now become a lucrative option for institutional and corporate investors to diversify their portfolios. In 2016, Apple Inc. was the first company to issue a Green Bond (1.5bn US$; 7 years; 2.85 semi-annual coupon) with the intention to invest in renewable energy and energy efficiency of its facilities (Clarity 2022). Many others have since followed their example. In China, Green Bonds play a crucial role in the financial industry of Green Products. In 2015, the PBOC issued a declaration concerning the issuance of Green Bonds in their interbank bond market for the first time and has since established the world's largest Green Bond market (Asian Development Bank 2020).

The progress in terms of scale and quality of these bonds happens rapidly. The 2019 "*Review of China's Green Bond Market Development*" reported that 542 Green Bonds were supplied domestically between 2016 and 2019 (Climate Bonds Initiative 2019). The total size of China's international and domestic Green Bond issuance in 2019 was 339.062 billion RMB, an increase of 48% compared to the previous year. During this period, China accounted for about 21.3% of the global Green Bond issuance (Ehlers et al. 2020).

Many state-owned enterprises (SOE) in China use these bonds for large-scale infrastructure projects such as clean energy power plants, railways, urban wastewater treatment plants, or as part of the Belt and Road Initiative. Critics argue that there is no evidential correlation between rising Green Bond issuance and the reduction of CO_2 emissions (ibid.). Several bonds have also been accused of not meeting international definitions and, therefore, of greenwashing. Nevertheless, it can be said that the Development, Industrial, and Commercial Banks of China all advance the quality of climate bonds and set the standard for other institutions worldwide with an increasing product range and improvements in regulation (Jun Ma 2019).

4.2.2 Green Credits

The most significant force in Green Finance in China are banks. By the end of 2017, Chinese banks' total Green Lending market accounted for about 1.1 trillion US$, around 9% of their overall lending (OECD 2020). Green Credits, as the most prominent form of Green Lending, refers to the practice of banks taking not only economic factors but also environmental

indicators into account when issuing credits and making loan decisions (Thompson and Cowton 2004). When issued, they require banks to assess and price environmental risks because the bank will have to bear jointly should the credit beneficiary cause unwarranted pollution after obtaining the credit funds. Demand for Green Credits has been enormously high, particularly for innovation projects, which is why they are widely regarded as one of the most potent instruments in Green Finance policy (Yao et al. 2021). Despite being successful overseas in promoting sustainability and Green Innovation, the effectiveness of Green Credits in China was not a given since nationalized commercial banks do not represent the core of China's financial industry. Instead, Chinese sustainable finance is primarily championed by state-owned commercial banks like the Bank of China, the Agricultural Bank of China, and others.

The first Green Credits in China were officially launched in 2007 as part of the conservation initiative developed by the PBOC. At the beginning of 2012, the Chinese central government issued and implemented their Green Credit Guidelines (GCG). The Chinese GCG are unique to other countries' guidelines because of the high involvement of the state in the policymaking process. This makes the GCG and its designated regulatory body, the China Banking Regulatory Commission (CBRC), more powerful than its equivalent in other jurisdictions because it is supported by government interests (Wang et al. 2019).

Studies by Lyu et al. (2022) analyzed the effectiveness of Green Credits and their relation to innovation in the Chinese market. The Chinese market is particularly interesting for such analysis because its immature market environment has in the past rewarded ecologically hazardous behavior and did not provide incentives for companies to act eco-friendly on their own, perhaps even the opposite. The study discovered that, on average, low-carbon innovation increased by 0.491% for every 1% increase in Green Credit in the Chinese market (Lyu et al. 2022). Other studies showed that the Chinese Green Credit policy negatively affected the general performance of the firms using them. This was especially true for SOEs and companies from heavily polluting industries, which the two beforehand either benefitted greatly from resource-heavy practices or had easier access to external R&D funding, or both (Yao et al. 2021). Since local economic growth is rewarded on a provincial, not a central, governmental level in China, the effect of the GCG vanishes in the less developed and low-GDP provinces. Some of the local governments of the provinces that are lagging behind in

economic power reject the implementation of the GCG or don't provide accurate data by their local Environment Protection Bureaus (EPB) (Huang et al. 2023).

Proposed solutions to the mentioned issues of Green Credits in the Chinese market comprise more consistent and forecastable policy changes and stronger supervision of small and medium-sized enterprises (SME) to create an even level playing field for all firms. Furthermore, the relevance of meeting environmental standards for provincial governments needs to be increased, and a more balanced economic performance model must be presented to provincial authorities (ibid.).

4.2.3 Green Insurance

The Chinese insurance industry has steadily increased its offerings for Green Products. The products comprise offerings ranging from business-focused insurances like environmental liability -/ or Green Supply Chain Insurances to consumer-oriented ones like Climate Change Adaption Insurance, which protects against causalities from extreme weather events. Just like regular insurance, Green Insurance is meant to provide risk protection, with the addition that it rewards ethical behavior in accordance with ESG (Clubley 2023). To support the low-carbon transition, companies pursuing Green Insurance offerings play a major role in enabling Green Industry Projects. In addition, it contributes to long-term environmental investment decisions that require intensive R&D backing, as illustrated in Figure 16.

Figure 15: *Theoretical Framework (Hu et al. 2023)*

From 2018 to 2020, the investment portfolio of Chinese Green Insurance funds grew by 19.17%, rising from 310 million Yuan to 450 million Yuan (Belozyorov and Xie 2021). The total Chinese Green Insurance coverage grew in the same period from 12 trillion to 18.3 trillion Yuan and is expected to hit 31.7 trillion Yuan in 2022. This would signify an increase of 164% in only five years (Statista 2023f). In the future, integrating fintech into the Chinese Green Insurance industry and unified databases of environmental pollution could further improve the product

portfolio and transparency for customers and the regulatory commissions (Belozyorov and Xie 2021).

4.3 Remaining Challenges in China's Green Finance Development

As we have seen, China has gone a long way in a reasonably short time in Sustainable Finance and also sees itself as a pioneer in the domain. As the largest economy (*in PPP adjusted GDP*) and largest emitter of GHG globally, progress in Green Finance is urgently needed in its proclaimed path to an ecological civilization.

Despite good efforts, there are obstacles that could slow down further development that need to be considered in the Chinese financial system:

- *Information Asymmetry for Green Financial Data*

In order to foster transparency, responsible investment practices, and sustainable development, it is crucial to incorporate ESG information into the corporate disclosure frameworks of entities engaging in Green Finance. In addition, as the Chinese government has already recognized, misinformation and false environmental data must be reduced.

During a statement from March 14th, 2022, the Ministry of Ecology and Environment (MEE) issued a note saying: "*Accurate and reliable data is the lifeline for the effective and standardized operation of the carbon […] market*" (Xu and Stanway 2022), as part of a collective lawsuit against several Chinese firms for falsifying carbon data. Part of the solution to that is to lower the pressure on provincial governments on their Cadre Performance Evaluation System (CPES) and to set realistically achievable goals. Previous high-pressure deadlines like the 2017 "*2+26*" area energy infrastructure reform, where coal plants had to be immediately shut down to meet nationally declared carbon standards for 2018, resulted in short-term decreased emissions but led to an even increased coal-plant infrastructure just two years later (Li and Shapiro 2020).

- *Lack of a cohesive Green Financial System*

Standardizing the various existing approaches into one Green Financial Scheme, which targets China's 2030 emission peak and 2060 carbon-neutral goals, lays the foundation for all other measures to work. To accomplish this, practices can be derived from the List of Green Bond-Backed Schemes of 2021 (PBOC 2021). So far, the taxonomies have not been well-coordinated, which lead to various standards in the China Banking and Insurance Regulatory Commission (CBIRC), the PBOC, or the National Development and Reform Commission (NDRC), that each

are responsible for their own product category, but follow no unified overarching logic (Larsen 2023).

- *Alignment in policies and standards*

Standardizing the various existing approaches into one comprehensive Green Financial System would serve as an incentive for the market to employ more Green financial Products. So far, businesses as well as local governments don't fully understand Green Finance, and hence rely on the longer established finance tools (Zhou 2022). Therefore, The Chinese top-down market approach provides unique opportunities for agile policy-making since no central barrier like the ECB in the EU needs to be consulted. In the case of China, this independence leads to unique and innovative policies, but also to a lack of coordination and a leading authority (Larsen 2023). So far, the market for China's Green Finance system has been dominated by Green Credit, which accounts for over 90% of its overall Green Financing. Aligning policies can lead to an overall increase in trust and usage of Green Financial Products, and potentially nurture the so far underutilized products such as Green Funds, Green Insurance etc. (Feng et al. 2023).

- *Insufficient encouragement for ecological behavior*

Recently, programs like the dual credit policy have created incentives for companies to interact with Green Financial Products. Further policy tools, such as a tax reduction system that rewards Green Bond issuance and usage, or Green Consumption and innovation as a whole is needed to profitably circulate Green Funds and increase adoption (ibid.).

4.4 Green Venture Capital

The International Renewable Energy Agency (IRENA) has forecasted a deficit of $ 27 trillion that needs to be invested to ramp up renewable energy supply by 2050 to be in line with the goals of the Paris Agreement (IRENA 2018). A large part of that must result from public spending and investments by large corporations from the energy sector. However, alternative solutions and innovation will contribute to winning the race against time. In recent years, said innovation has often come from the spawn of venture capital (VC) investments. The VC industry has lately seen record growth, reaching an all-time high with more than 288$ billion invested globally in the first two quarters of 2021, according to Crunchbase (Teare 2021).

To evaluate the efficiency of VC in Green Technology, it is vital to understand the distinctive characteristics of VC investments. Figure 17 describes how, i.e., the investment cycle, risk

appetite, and success factors deviate from common industry investments. In Chapter 4.4.2, we will go further into the distinct differences between traditional and Green VC investing.

Comparison of Industrial Investment and VC		
	Industrial investment	**VC**
Form of investment	Exchange funds for real assets without participating in business management	Exchange capital for equity and participate in business management
Project evaluation	Focus on financial analysis and technical guarantee	Focus on the technology and innovation of the project
Investment cycle	Short	Long
Target	Short-term profits	Long-term profits
Income and risk	Low return and low risks	High returns and high risks
Investee	Enterprises in comparatively mature industries	Enterprises in emerging industries

Figure 16: *Comparison of Industrial Investment and VC (Lin and Xie 2020)*

The main market for all types of VC is the North American one. U.S. examples of Green VCs include Climate Capital or Earthshot Ventures. In Europe, the main VC markets are in the UK, France and Germany. Examples are World Fund or Planet-A Ventures (Groszkowska 2023). The Asian VC market is dominated by China, about 80% of large VC investments flow into Chinese startups (The Asset 2023). Entirely Green VCs are in China yet a rare sight, exceptions are early-stage Green Funds like Green Leaves Investment or Lightspeed China Partners (XYZ Lab 2023; ClimateHack Weekly 2023).

4.4.1 Differences to Mainstream Venture Capital

While the investment process itself does not greatly differ between mainstream -/ and Green VC, several key variables separate the two. Firstly, the type of start-up which both invest in is not the same. Environmental start-ups generally operate with high risk and small size while having high capital demands for a long period (Gu et al. 2018). This leads to a longer investment duration, as shown in research by (Ghosh and Nanda 2010). Conventional VCs operate within a 2-3-year timeframe, in contrast to Green VC investments, whose investment cycle typically ranges from 3-5 years (O'Rourke et al. 2003).

Another key difference is the outlook on sustainability: Traditional VCs usually view environmental concerns as a potential liability or risk factor. Green VCs see Green Innovation as an increase in value to the company. This allows Green VCs to consider their ROI from sustainability and an investment perspective, generating double dividends, emission reduction, and financial returns (ibid.). Green VC as a form of sustainable investing, as previously discussed, also deviates from traditional investing, since it is a more altruistic form of financing. Even further societal considerations would be considered as philanthropy or charity, as described in Figure 18.

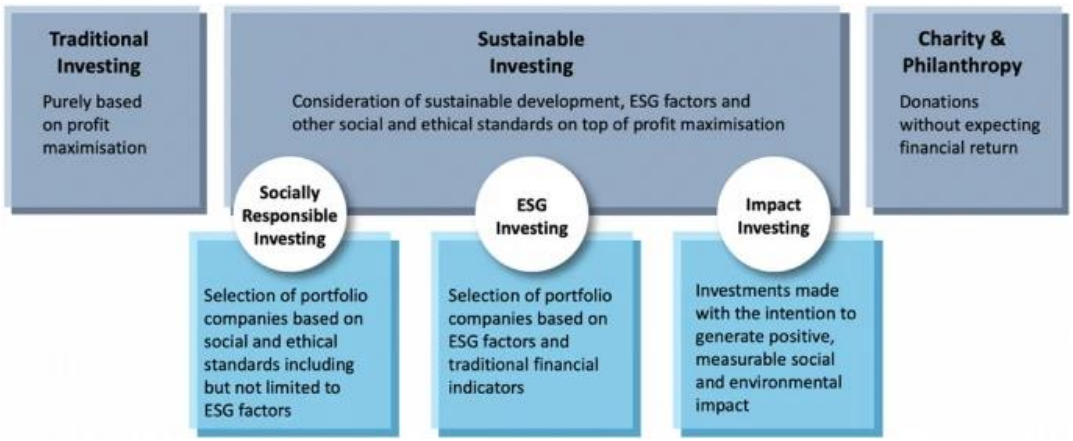


Figure 17: *Concepts Related to Sustainable Investing (Lin 2022)*

4.4.2 Venture Capital as a Funding Instrument for Green Innovation

VCs contribute financial support and resources to high-tech start-ups without the immediate need for a return on investment and can thus foster the Green Innovation of high-tech start-ups (Hall and Helmers 2013). In comparison to other financing avenues, venture capital is particularly well-suited for sustainable investments, given its distinctive attributes:

- *Consonance with the needs of sustainability start-ups*

Angel investors and VCs often bring industry knowledge, relationships, or other relevant assets alongside their financial investment (Lin 2021). This allows the portfolio company to accelerate development and potentially access opportunities for new distribution, production, talent, etc. The long lock-in period VCs generally have on their investment also aligns well with the generally extended R&D phase it takes for innovative start-ups in the environmental industry (ibid.).

- *Unique investor protection mechanism*

Venture capital investing generally happens in seed rounds. Some VCs specialize in early-stage (Pre-seed or seed A/B), and others in mid-/ late-stage (Seed C+) investments. The later

the seed round, the more capital and less equity is usually at stake. Most VCs place their investment attached to certain conditions that must be met until the next financing round (Harvard Business Review 2021). In the case of sustainability start-ups, these conditions could be to match criteria to qualify for ESG standards or similar (Gilson 2002). Meeting these conditions gives the entrepreneurs an extra incentive to work hard in order to increase their position for the next financing round. Also, for their acquired equity, VCs usually receive a disproportionally large amount of voting rights over the start-up (ibid.). For genuine, purist Green VCs, this means more involvement to steer their portfolio companies in a sustainable direction.

4.4.3 Sustainable Venturing (B Corp Certification)

Amidst the increased accountability of companies and acknowledgment of not only stakeholder value maximization but also the obligations to non-stakeholders, eco-certifications have become a welcome tool to demonstrate good behavior. Many of the more prominent certifications, such as the ISO 14001, the Impact Reporting Investment Standards (IRIS +), or the Global Reporting Initiative (GRI), focus only on specific aspects of a company. One certification that evaluates the entire performance and provides a comprehensive impact report with scores on each area is the B Corp Certification (Diez-Busto et al. 2022). To achieve the B Corp, a business must pass a rigorous audit and sign a public legal declaration of intent to consider external impacts of their business activities. The B Corp has proven to be a reliable non-governmental tool to hold businesses accountable and reduce greenwashing (Johnson 2022). While, in the past, such strict certificates scared off potential venture capital investors from Start-Up investments, similar or more start-up-specific certifications could become a valuable instrument when pursuing impact investing (Cultivating Capital 2019).

5. Impact of Venture Capital on Sustainability in China

Labeled by the United Nations as the "*key market*" for Green Finance and urged by government incentives and campaigns to promote innovation and sustainability, China's VC investment environment is gaining increasing significance (Cheng et al. 2019). Green Technology Innovation is widely regarded as the fundamental solution to solving climate challenges and shifting sustainable growth in the renewable energy (RE) sector.

Chinese private market transaction trends are changing toward a more sustainability-centered direction. However, despite promising Green Investments in 2022, China's most vital startup sector, centered around its innovation hub Shenzhen, remains to be tech. Information Technology was by far the most discussed industry by China funds in 2020-2022 (Zhang 2022), and eight of the ten largest startups in China are from the tech industry. Nevertheless, the trends illustrated in Figures 19 and 20 show that Chinese investments are firmly heading toward sustainability.

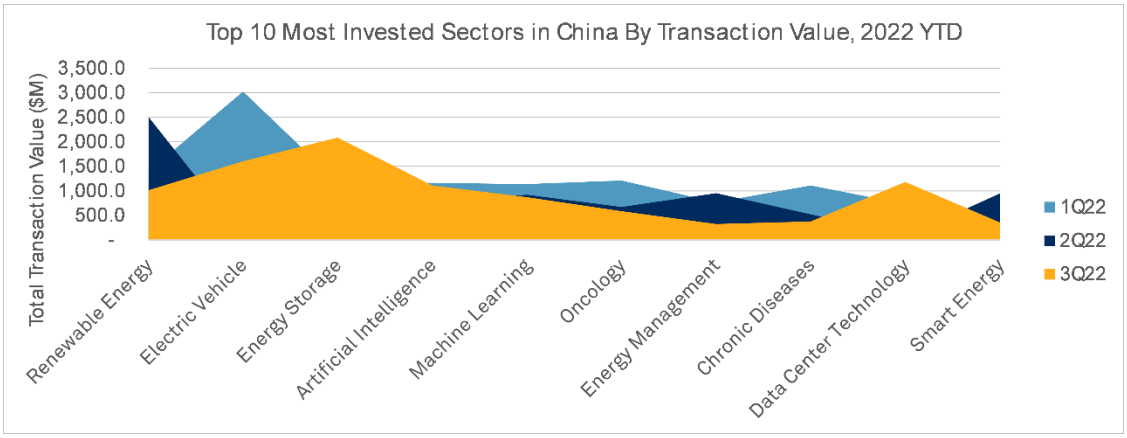


Figure 18: *Most Invested Sectors in China by Transaction Value 2022 (Zhang 2022)*

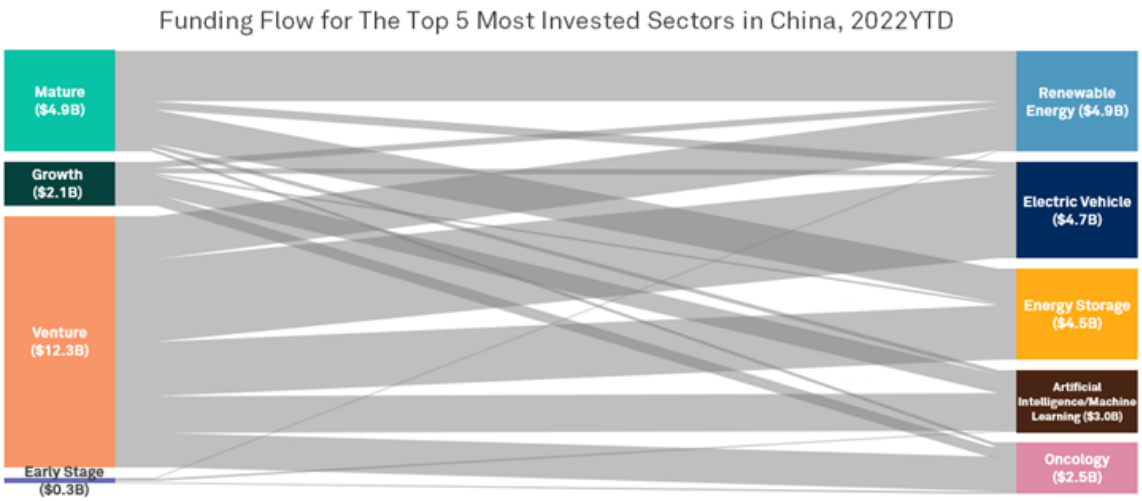


Figure 19: *Funding Flow in Most Invested Sectors in China 2022 (Zhang 2022)*

According to KPMG, the Chinese Initial Public Offering (IPO) market performed exceptionally well in 2022, particularly in comparison to other Asian countries, giving strong feedback to VC investors who have lately seen successful seed rounds and exits (KPMG 2023). While Hong Kong, for example, has predominantly seen VC funding flow into Fintech startups, Mainland China raised the majority of its funding for energy and EV companies. Seven out of ten of the largest VC deals in Asia in 2022 happened in China. *SPIC Hydrogen Energy (631 mil. US$ seed B)* and *Voyah Car Technology (630 mil. US$ seed A)* are the two cleantech deputies of that list, accounting for the third and fourth largest Asian VC investment of that year (KPMG 2023). Figure 21 shows how China, in terms of capital flowing into climate tech, is becoming increasingly competitive even with North America, which has been, and still is, considered by some to be the only relevant VC market.

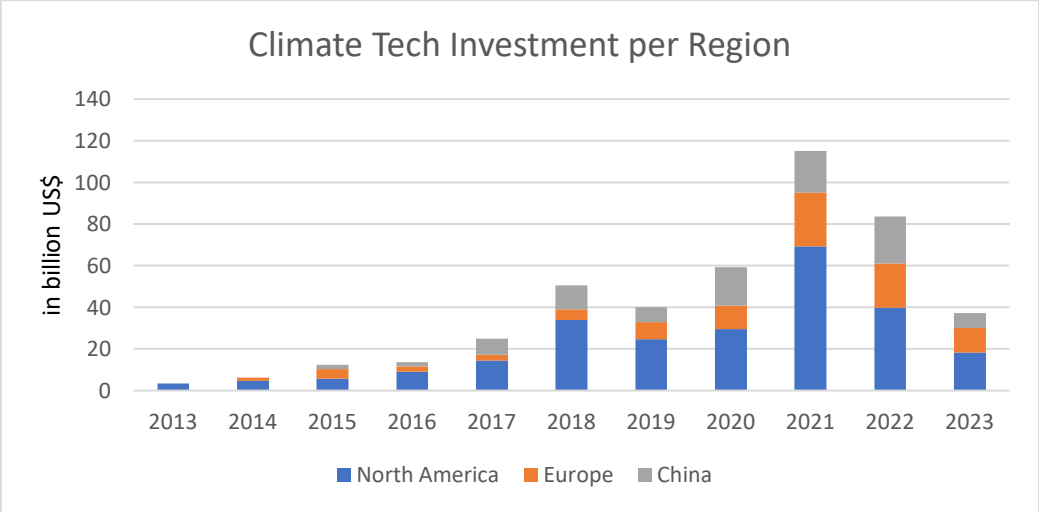


Figure 20: *Climate Tech Investment per Region (PWC 2023)*

5.1 Green Start-ups

Of the top 300 most promising startups listed in China for 2023 by Failory (2023b), seven have a link to sustainability matters. Five of these sustainability startups did receive VC funding at some point, also from major US-American players. Two of the VC investments came from a specialized Green VC fund, which are yet a very rare occurrence in China. The two EV startups received ample corporate funding or private equity backing at some stage but did not turn to VC (ibid.).

2023 Promising Sustainability Startups

Company name	Industry	Investors	Founding year
Meicai	Agriculture, E-Commerce, Food & Beverage	Tiger Global Management, ZhenFund, Shunwei Capital, **Hillhouse Capital Group**, CMC Capital Group	2014
Hello TransTech	Ride Sharing, Transportation, Cycling	**GGV Capital**, Ant Group, WM Motor, Primavera Capital Group, Fosun International	2016
Hive Box	E-Commerce, Logistics, Packaging Services	**Sequoia Capital China**, Trustbridge Partners, CDH Investments, GLP, STO Express	2015
XAG	Agriculture, Drones, Farming	**SoftBank Vision Fund**, **Sinovation Ventures**, **GL Ventures**, Hillhouse Capital Group, SFUND	2007
Clobotics	Agriculture, Analytics, Computer Vision	**GGV Capital**, Wangsu Science & Technology, CMC Capital Group, CDIB Capital, **KTB Ventures**	2016
BAIC BJEV	Automotive, EV, Manufacturing	Daimler, China Cinda Asset Management, Zhongji Investment	2009
HOZON	Automotive, EV, Manufacturing	Hongli Zhihui Group, Guojin Capital, Yangtze Delta Region Institute of Tsinghua University, Zhejiang, HD Capital	2014

Figure 21: *Promising Chinese Sustainability Startups (Failory 2023a)*

5.1.1 Climate Tech Unicorns

Figure 22: *China Climate Tech Unicorns (HolonIQ 2023)*

As of 2023, China has 162 unicorns. 17 of them are in the climate tech industry (Failory 2023a). This has China ranked globally in the second position, after the United States, which inhabits 29 sustainability unicorns. Therefore, around 10% of Chinese unicorns operate in, or are related to the climate tech industry. This is high above the global average of 4.3% (HolonIQ 2023).

5.2 Industry Deviations between China and the West

There are three different types of VCs in China: independent VCs (IVC), governmental VCs (GVC), and foreign VCs (Andonov 2022). Unlike in the West, large parts of Chinese VC investments come from GVCs. In 2016, Bloomberg wrote, "*China Is The Biggest Venture Capital Firm In The World*" (Shen 2016). These government-backed funds are part of the Made-In-China 2025 initiative and the realization that startups are integral to innovation. This leads to a more policy and agenda-driven VC environment than in the West. In 2018, this phenomenon was exemplified in a case where the portfolio of AMIIF, a GVC founded in 2016, underwent a significant shift. Within just one quarter, it transitioned from being primarily centered around the chemical sector to becoming entirely focused on electrical and industrial engineering. This repositioning likely happened as a direct response to tariffs in the US trade war (Chen et al. 2022). For IVCs and foreign VCs, doing business in China usually involves a certain degree of coerced institutional cooperation. In the case of VC, this primarily relates to collaboration and relationship building with large state-owned enterprises (SOEs), which are necessary to access the best investment opportunities (Ahlstrom 2007). On an interpersonal level, the concept of 关系(*guānxi*) networks or relationships plays a vital role in selecting the right venture partner

for both parties. Since business contracts and intellectual property are not as well protected as in the West, a deeper level of trust is mandatory (ibid.).

5.3 Limits for China's Green Venture Capital Investments

Despite its increasing occurrence, Green VC is yet a new phenomenon that has three issues that need to be improved to the status of being calculable side factors associated with sustainable investing.

Policy Impacts:

The presence of a reliable policy and regulatory framework has overall positive effects on Green Venturing. Times of evolving policies often scare off potential investors. This is why unifying existing frameworks in Chinese Green Finance, as mentioned in chapter 4.1, also holds great significance for the dynamics of Chinese Green Venturing (Cumming et al. 2013). Entrepreneurs in emerging markets also often do not just manage internal processes regarding their startup, they also have to act as political entrepreneurs lobbying for policy changes. This long-term process delays potential innovation, the time horizon for exits, and consequently also fears off investors (ibid.).

Exit Mechanism:

The Chinese VC market has received large amounts of funding since for the past 15 years. Especially the boom around China's startup hub in Shenzhen regarding the BAT (*Baidu, Alibaba, and Tencent)* companies, the equivalent to the US FAANG (*Facebook, Amazon, Apple, Netflix, Google)*, has led to tremendous investor appetite (Lu 2018). However, so far only few of the investments reached the stage of an IPO. CNBC reported that in the period 2015-2020 only four US-American China-focused VC funds managed to return net positive for their investors. The Chinese VC exit period is much longer than in Western markets. Investors can expect a 20-to-30-year period to exit, compared to the average 5-to-10-year exit window in Western markets, according to Alex Shum, managing director of TPG NewQuest, a large Hong Kong based Private Equity firm (Cheng 2023).

State-financed clean tech:

Unlike in the West, despite a strong VC market in China, when looking at climate tech development, major advancements rarely had VC involvement. The big players in the Chinese sustainability sector all have an SOE or government-led initiative sponsoring and subsidizing

expenses (CTVC 2022). While subsidies are a powerful tool to boost specific industries, this mechanism in the short-term closes market potential for startups, as they cannot compete in terms of R&D and process funding.

5.4 Opportunities for China's Green Venture Capital Investments

Green Investments have globally become more and more of a trend. The number of ethical funds where capital is directed toward environmental startups is growing. Especially in the more liberalized Western markets, specialized Green VCs are emerging and evolving the VC space as a whole, looking for new formats to measure low-carbon performance and broaden the range of indicators investors look at (Cumming et al. 2013).

Perhaps this trend will spill over to the Chinese market, which in terms of Green Investment already ranks first in energy transition (*renewable + non-renewable energy*) investments, by more than two-fold to the second place, the United States (Bhutada 2022). These investments in the energy sector, at the scale of China's economy, enable an outstanding sectorial growth opportunity for startups in renewable energy, cleantech, EVs, energy storage etc... Private investors have followed the sustainable investment opportunity for the last consecutive years (Preqin 2023). Network effects of the first layer solutions may enable smaller startups to benefit from the growing industry, just like protocols in the crypto industry that built on one blockchain benefit from other projects thriving within their blockchain ecosystem. An influx of sustainability interested private investors can already be registered. The number of Principles for Responsible Investments (PRI), a tool for private impact investing introduced by the UN, registered a steady increase (Fig. 24). In order to realize this market potential, China will need to further open its markets to private investors (ibid.).

Figure 23: *PRI Fund Manager Signatories in Greater China 2015-2020 (Preqin 2023)*

5.5 STEP Analysis – Impact of Venture Capital on Sustainability in China

A STEP Analysis is a multifaceted approach to assess big-picture forces in order to better understand the main factors when analyzing the impact of a certain topic. The tool offers macro-environmental factors that decision-makers need to consider for comprehensive evaluation.

STEP Analysis **Impact of Venture Capital on Sustainability in China**	
Social	Social capital and *guanxi*, is considered a vital component for the Chinese market and societal structure. As sustainability did not play a large part in Chinese culture during the miraculous upbringing of the Chinese economy since the opening up in 1979, low-carbon ventures are something that needs to be incentivized and promoted by political campaigns and subsidies. So far Green Startups have mainly been funded by state-owned funds or companies, Green VCs, FVCs or IVCs did not play as much of a role. Their involvement, not only financially, but also human capital and industry knowledge could further progress China's low-carbon startup culture.
Technological	Some of the most emission heavy industrial sectors in China like steel, chemicals and cement are not typical VC industries and therefore

	unlikely to be an industry where VC investments will play a role. Typical low-carbon investments by VCs have been, i.e., in energy transition, transport, land-use, circular economy, new mobility, new materials and green buildings. VC investment did play a major role in that as seen in Figure 19.
Economical	China's VC funding into Climate Tech totaled 10.7 billion US$ in 2022, a 70% increase from 2021 (Statista 2023a). The total VC investment into the Climate Tech sector from 2010 to 2022 accounts for about 50 billion US$. US VC funds invested about 90 billion US$ in the same period (Statista 2023b). China's global share of Climate Tech investment overall increased, but in VC investment overall it decreased. Recently, major Chinese VC funds partnered up to establish specialized low-carbon transition funds which already have a funding of several billion US$. Green VCs have so far been, as mentioned, an anomaly in the Chinese VC industry and did not participate in the most significant funding rounds. Green VC industry knowledge has therefore not been leveraged in the Chinese VC market.
Political	GVCs and investments by SOEs have dominated the Chinese VC industry. The IPO process in China is highly regulated, requires provincial as well as central government approval on different levels and is long and unpredictable, which makes VC investments in China generally less interesting for investors. The VC-funded Clean Tech bubble of 2005 to 2008 busted due to too little demand for clean energy technology. The overall increased energy demands paired with societal and contractual pressure to improve carbon intensity seem to be the right foundation for a rebirth of the Clean Tech industry alongside China's high-tech ambition of campaigns like *Made-In-China 2025*, or the formulated ambitions of the 14th FYP.

Figure 24: STEP Analysis Impact of Venture Capital on Sustainability in China

6. Conclusion and Outlook

My in-depth research on the progress China is making toward becoming a low-carbon economy, particularly from the lens of institutional and private market investing. I therefore first clarified this new low-carbon concept of an economy and how sustainability gained importance in Chinese politics over the recent years. Based on this context, I specifically focused in the first place on advancements in reaching a Green Taxonomy, as the EU provided one in 2020, and the individual levers used by Chinese banks to promote Green Finance. Lastly, I looked into the Chinese startup sector, particularly into the financing in how Green Chinese ventures are funded.

Based on my findings about China's Green Finance development China has, with its top-down structure, achieved applaudable advancements in the product range and applicability of green financial products. In 2021 China opened its Emissions Trading Scheme, the first Asian country to do so, and in 2023 the previously due to low volume closed voluntary carbon market reopened. While sustainability efforts in China seemed to have slown down for a few years, the spirit in the world's largest carbon market appears to be nascent. Nevertheless, experts deem Chinese efforts not to be sufficient, especially in conjunction to the continuously high carbon output. If a heatmap was drawn for actions that need to be taken to further China's position as a player in Green Finance, a focus should be placed on the most impactful and least complex topics. As such, aligning the regulatory framework lays the groundwork for most of the problematic areas. For instance, the regulatory consistency between provincial governments and regulators needs to be ensured and a common green vision incentivized. Unifying various Green Finance policies, such as the GCG or the frameworks presented by the PBOC into one Green Taxonomy, just like in the EU, would provide better transparency, clearer paths for investors and therefore higher volume into these new markets. One operation that could work as a light house project for Green Financing is the Green BRI.

In terms of early-stage investments in China, a lot of funding is going toward the low-carbon transformation. This funding has produced a healthy amount of green unicorns, also in global comparative perspective. The two main concerns for investors, especially for foreign ones, is the inert IPO activity and the high share of governmental VCs. The relevant funding rounds

have also so far barely had involvement of impact driven Green VCs, as they are a rarity in the Chinese VC market that has its unique characteristics.

To summarize the situation, China's influence in global CO_2 emissions is enormous. Chinese investments in the green sector can have a downward spiral on the cost of energy worldwide, and therefore reduce emissions globally. The Green Finance sector along with all the investment opportunities tied to it, present a unique opportunity for China to leverage its position as a global leader in low-carbon transition. China has realized this potential and established mechanisms that promote green growth on a national level. It remains to be seen if plans made for 2025, and the emission peak in 2030 can be met as scheduled, the 15th FYP will give great insight about the fitness level of China's economy and political leadership in keeping its ambitious promises.

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