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Analysis of the Impact of China's Carbon Neutrality Policy on the Environment and Economy at Home and Abroad

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Abstract: China has made remarkable achievements in reducing greenhouse gas emissions, especially in achieving the emission reduction targets set for 2020. This progress is mainly due to China's reduced dependence on coal and other fossil fuels, which not only promotes significant improvements in air quality but also lays the foundation for the transformation of China's economic structure. Especially in the energy and industrial fields, carbon neutrality policies are driving companies to transform into greener and more sustainable operating models. Facing the economic challenges brought about by the COVID-19 epidemic, China is actively seeking a path to low-carbon economic recovery by increasing public investment in renewable energy and other fields. From an international perspective, China's carbon neutrality commitment has the potential to inspire other large carbon-emitting countries, especially countries along the Belt and Road and neighboring countries, to strengthen their emission reduction efforts. At the same time, Southeast Asian countries face shortages of technology, equipment, and raw materials, as well as insufficient investment when developing renewable energy. In this regard, China's experience and investment have a significant impact on Southeast Asian countries' carbon neutrality policies and renewable energy development. China can use its technological and manufacturing advantages to share resources with neighboring countries in renewable energy technology and equipment manufacturing, and provide support for ASEAN countries to achieve their renewable energy goals.

Keywords: China, carbon neutrality, climate, economy, Southeast Asia

1. Introduction

In the early 21st century, global climate change has become an urgent global challenge. According to the "Special Report on Global Temperature Rise of 1.5°C" published by the IPCC [1], carbon neutrality is defined as the ability of man-made CO2 removal to offset man-made CO2 emissions on a global scale during a specific period, thereby achieving net zero CO2 emission. The report also emphasizes that only by achieving global net-zero carbon emissions—the goal of carbon neutrality—by the mid-21st century will it be possible to limit global warming to 1.5°C, thereby mitigating the extreme harm caused by climate change. However, the United Nations Environment Program (UNEP) pointed out in its "Emissions Gap Report 2019" [2] that there is a significant gap between countries' emission reduction ambitions at this stage and the requirements of the 1.5°C target.

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In this scenario, as the world's largest emitter of greenhouse gases, China's role in addressing climate change has attracted widespread attention from the international community. In recent years, the Chinese government has gradually realized the seriousness of this problem and has formulated and implemented a series of policies and measures to address climate change. Among them, the most prominent one is China's goal of "carbon peaking and carbon neutrality" [3]. In short, the goal means that by 2060, China's carbon emissions will peak and gradually decrease, eventually achieving carbon neutrality, that is, a balance between annual carbon emissions and absorption. This ambitious goal demonstrates China's determination and sense of responsibility in global climate governance. But at the same time, it also brings a series of challenges and problems. In addition, what impact will China's goal have on its neighboring countries, especially its economic partners such as Southeast Asian countries?

This article aims to delve into the possible impacts of China's carbon neutrality policy. First, this article will examine the positive environmental impacts of this policy, including reductions in greenhouse gas emissions and improvements in air quality. Next, the impact of this policy on China's economy will be analyzed, especially in terms of industrial structure transformation and investment and innovation promotion. Finally, this article will explore the impact of this policy on neighboring countries, especially Southeast Asian countries, to provide valuable references and suggestions for these countries.

2. The impact of China's carbon neutrality on the atmosphere

The relationship between China's development and climate change is complex and closely related. As one of the world's largest emitters of greenhouse gases, China plays a vital role in the intensification of global warming. At the same time, it is also profoundly affected by the negative impacts of climate change. Like other major greenhouse gas emitters, China plays a critical role in reducing global climate risks. However, for a carbon-intensive industrialized economy like China, reducing greenhouse gas emissions and improving air quality is no easy task. This requires not only technological innovation and policy adjustments but also profound changes in economic structure and energy use patterns.

2.1. Greenhouse gas emissions

Before 1970, China's total CO2 emissions were less than 0.9 Gt, and per capita emissions were about a quarter of the global average. Since the reform and opening up in the 1970s, especially after joining the World Trade Organization in 2000, CO2 emissions have increased with the rapid growth of the economic aggregate (as shown in Figure 1). China's CO2 emissions grew at an average annual rate of 10% in the 1970s, 5% in the 1980s, 3% in the 1990s, 9% in the 2000s, and 3% in the 2010s (Figure 1 shown). At the same time, per capita CO2 emissions have also increased, snowballing from 2000 to 2013 and then stabilizing (shown in Figure 2). In terms of carbon emission intensity, it has gradually shown a downward trend since 1980 (see Figure 2). As of 2019, the national CO2 emissions are 10.3 Gt (±13%, confidence interval (CI) = 90%), and the per capita CO2 emissions are approximately 7.4 t [4, 5, 6, 7].

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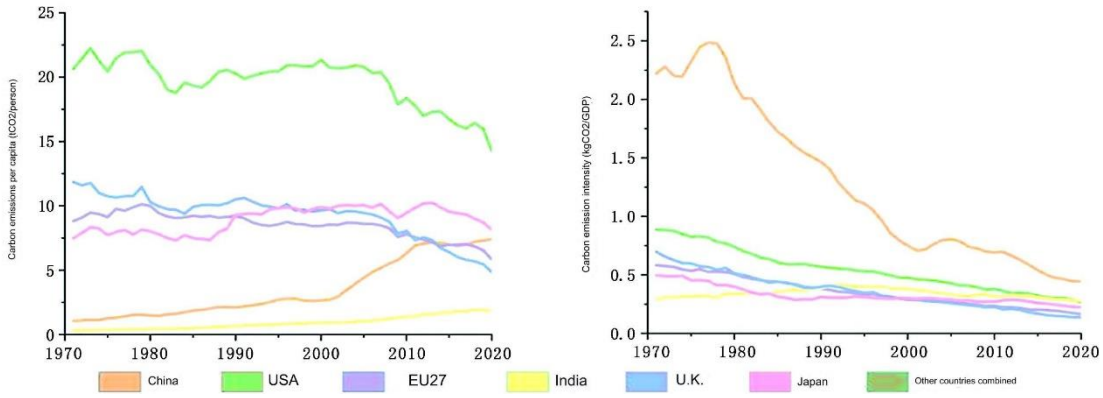

Figure 1: China's carbon emission trend chart [4,5].

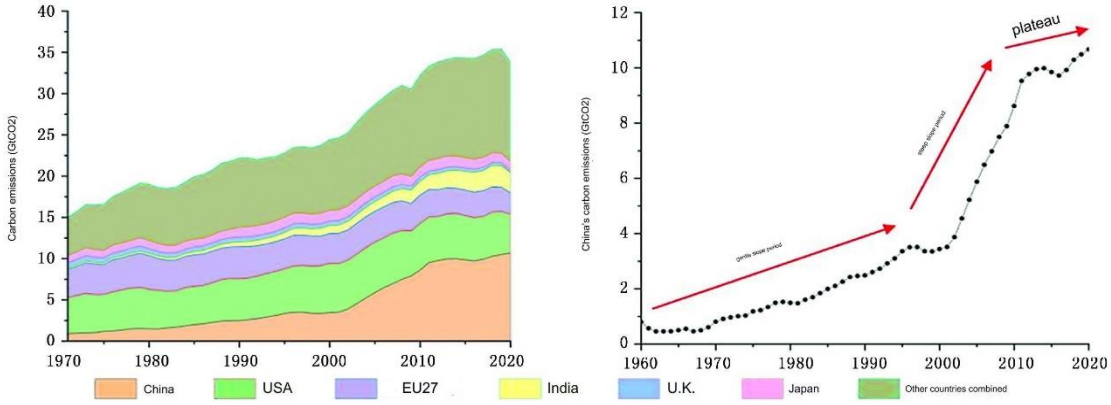

Figure 2: Comparison of per capita carbon emissions and carbon emission intensity [5,6].

2020 is a critical time point for China's carbon emission reduction goals, that is, the carbon emission intensity will decrease by 40% to 45% compared with the same period in 2005, and the energy intensity and carbon emission intensity of the "13th Five-Year Plan" will be reduced by 15% and 18% respectively compared with the same period in 2015. %, China has now achieved the above goals. As of 2019, China's carbon emission intensity has been reduced by 48.1% compared with 2005. By 2020, this indicator has reached 48.4%, fully completing the target of 40% to 45% [8]. In 2020, the proportion of non-fossil energy in the country's primary energy consumption reached 15.9%, and the corresponding target was also achieved. The corresponding goals in the "Thirteenth Five-Year Plan" outline have also been achieved. As of 2020, compared with 2015, carbon emission intensity has been reduced by 18.8%, exceeding the 18% target; the proportion of non-fossil energy consumption in primary energy consumption has increased to 15.9%, exceeding the 15% target.

2.2. Improvement of air quality

As the dependence on coal and other fossil fuels diminishes, there is a corresponding decline in the release of associated pollutants like sulfur dioxide, nitrogen oxides, and particulate matter. According to statistics from China's Environmental Monitoring Center [9], there has been an approximate 30% reduction in PM2.5 concentrations in the ten largest cities of China since 2013. This positive change is particularly evident in expansive urban areas. Historically, severe smog in large urban areas resulted from the extensive use of coal and significant emissions from vehicle exhaust. Nevertheless, in recent years, there has been a notable enhancement in air quality in Beijing, attributed to China's implementation of green energy policies and stringent pollution control measures. The data illustrates

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that Beijing's average PM2.5 concentration was 89.5 micrograms per cubic meter in 2013, but by 2020, this figure had decreased significantly to 38 micrograms per cubic meter.

As air quality improves, many cities in China are starting to become more livable. Shanghai, China's economic center, has also made efforts to improve its air quality in recent years. By promoting electric vehicles, strengthening industrial emission standards, and improving fuel quality, we achieved 300 consecutive days of good air quality in 2018, a significant improvement from 220 days in 2013 five years ago, and improved people's health. It has also been improved. According to a World Bank report, due to improved air quality, the number of premature deaths caused by air pollution decreased by more than 100,000 in China in 2019 compared with 2012. Globally, China's carbon neutrality can reduce global warming by about 0.2-0.3°C and save about 1.8 million people from premature death due to air pollution [10].

3. The economic impact of China's carbon neutrality

The "China Country Climate and Development Report" (CCDR) [11] conducts an in-depth analysis of how China can strike a balance between high-quality economic development and achieving emission reduction, as well as enhancing climate adaptability. It presents relevant suggestions to address these challenges. According to the report, China faces the risk of hindering its long-term economic growth and prosperity if it fails to implement effective strategies for climate change mitigation and adaptation. Climate risks could even offset its development achievements. However, the report also cautions that measures taken to address climate risks should not result in slower economic growth and increased social inequality. Such outcomes could undermine opportunities for millions of people and decrease public support for the reforms necessary to drive long-term economic transformation. Therefore, China must navigate towards a reasonable equilibrium between economic growth and green development.

3.1. Transformation of economy and enterprises

China's transition towards carbon neutrality and resilient development will bring transition risks. Although addressing climate risks is extremely important to ensure long-term development, China also encounters unique challenges in achieving its climate and development goals: compared with developed economies, China needs to achieve economic growth at a lower income level and a faster pace. Decoupling from carbon emissions. This means that China's economic structure will undergo fundamental changes: energy, industrial, and transportation systems, and urban and land use patterns will all undergo major transformations.

3.1.1. Energy transition

Among the pivotal challenges in China's energy transition, achieving decarbonization in the energy supply sector stands out as particularly crucial. When examining shifts in China's energy landscape, two prominent features emerge the widespread adoption of renewable energy and the gradual reduction of coal utilization. Presently, China has surpassed the peak of coal consumption and is experiencing a gradual decline. Projections suggest that post-2025, as coal consumption rapidly diminishes, both primary energy consumption and carbon dioxide emissions will reach their zenith [12]. Simultaneously, renewable energy presently constitutes approximately 10% of primary energy consumption. Although its growth is gradual, its primary objective is to meet the escalating energy demand. In the forthcoming energy framework, renewable energy will play a pivotal role in bridging the energy deficit resulting from reduced coal consumption and holds the potential to emerge as the primary energy source, supplanting fossil fuels.

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3.1.2. Enterprise transformation

The carbon neutrality target set by China is pushing companies to transform towards greener and more sustainable operating models. This transformation encompasses measures such as adopting clean technologies, improving energy efficiency, and reducing greenhouse gas emissions. Professor Zhang Zhongxiang pointed out that although the increase in carbon costs will cause pain to enterprises in the short term, the government should not be affected by the emotions that may be amplified by enterprises [13]. When considering its stance on coal power and coal control, China must not only consider following global climate change agreements but also consider its economic development level and the actual situation of its energy structure. The CBAM proposal in the EU's Green New Deal, which aims to prevent carbon leakage, may have a greater impact on China and should attract attention.

3.2. Carbon neutrality and low-carbon recovery

The global COVID-19 pandemic has triggered the most profound economic contraction since the Great Depression. Governments worldwide are actively devising economic recovery policies in response to this impact. However, conventional economic stimulus measures reliant on energy consumption may worsen the irreversible trend of climate change and other environmental risks. In contrast, a low-carbon recovery, achieved through heightened public spending, particularly in areas like renewable energy investment, can establish a sustainable, low-carbon trajectory. The extended shift from a carbon-centric economy and the initiation of a low-carbon economy presents an opportunity to continue advancing global climate action [14]. For instance, in July 2020, the EU secured consensus on a $500 billion economic stimulus policy, with 30% earmarked for supporting climate action and implementing the European Green Deal, a pivotal policy document for the EU's carbon neutrality goal [15]. On June 3, 2020, the German government approved a €130 billion economic recovery plan, allocating €50 billion to "future programs" concentrating on "climate transition" and "digital transformation." This includes various climate change combating measures, such as initiatives in electric mobility, hydrogen technology, rail transport, and construction [16].

4. The impact of China’s carbon neutrality policy on neighboring countries—Southeast Asia

China's commitment to carbon neutrality is not only a major shift in its climate policy but also sets a new standard for global climate action and can be regarded as a "game changer" for global climate governance. China's efforts to reduce emissions have the potential to inspire other large carbon emitters, especially countries along the Belt and Road and neighboring countries, to increase their emissions reduction efforts. In addition, China can leverage its technological and capital advantages to share emissions reduction technologies and make green investments in neighboring countries. For Southeast Asian countries, China has strong capital strength and maintains close economic and trade relations. Especially under the framework of the "China-ASEAN Free Trade Area", the trade and investment ties between the two sides are increasing daily. This economic linkage allows China to share its green development experience in the region and promote sustainable development. These measures taken by China will play an important role in promoting low-carbon transformation and sustainable development in the region.

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4.1. Current Situation in Southeast Asia

Southeast Asia is one of the most climate-vulnerable regions on Earth - it faces brutal tropical storms, rising sea levels that threaten coastlines and cities, as well as massive flooding and severe droughts. According to the global climate risk index recently released by German Watch [17], three of the 10 countries most affected by climate risks from 2000 to 2019 are Myanmar, the Philippines, and Thailand. Furthermore, climate risk is removed from current projections unless governments implement more ambitious policies, provide stronger budget support, enact stricter measures to reduce fossil fuel use, and attract higher levels of investment, otherwise, Southeast Asia will not be able to achieve its net-zero emissions target by 2050.

4.2. Renewable energy technologies

The Association of Southeast Asian Nations (ASEAN) aims to achieve an ambitious target: 23% of its total primary energy supply should come from renewable energy (RE) within the next five years. This objective holds significance as the region experiences rapid growth in renewable energy alongside the decline of traditional power generation. By 2020, renewable energy generation constituted 31.4% of total electricity generation in the region. However, meeting the 2025 regional target necessitates increasing generation capacity to 166 GW. In this context, China possesses the opportunity to assist ASEAN countries in reaching their renewable energy goals through collaborative projects and technology transfer. China boasts advanced technology and extensive experience in traditional power technology, new energy development, and power grid construction and operation. A noteworthy regional cooperation project is the China-ASEAN Clean Energy Capacity Building Project [18], initiated by China within the China-ASEAN mechanism. The plan aims to enhance clean energy capabilities. While specific technical details remain unclear, this initiative underscores China's proactive role in regional clean energy cooperation.

4.3. Equipment and raw materials

Upgrading systems and aligning them for grid connection poses significant challenges for all ASEAN countries, requiring technical expertise, robust infrastructure, and integration with the Internet of Things [19]. Despite solar power emerging as the fastest-growing renewable energy source in the region, ASEAN heavily relies on China for equipment manufacturing and raw materials, a dependency exacerbated since the recent outbreak. Shortages in materials and photovoltaic equipment in the ASEAN market have led to the suspension of solar panel projects [20]. Concurrently, China's solar panel manufacturers, including Longi, Jinko Solar, Trina Solar, JA Solar, and Risen Energy, jointly appealed for increased electricity flexibility from the central government's energy department on September 30, 2021 [21]. Despite a decline in China's solar panel production capacity due to ordered reductions in electricity consumption, the country persists in constructing a renewable energy power system, guided by long-term planning. A similar approach to long-term planning may also be instrumental in shaping ASEAN's power system. In major ASEAN countries, state-owned power companies, acting as the "sole buyer" in the power market, can propel power system development by collaborating with energy authorities to formulate enduring industrial development plans. China and ASEAN could build upon existing foundations, expanding energy cooperation from project construction to sharing transformation experiences to aid ASEAN in reshaping its power system centered on renewable energy.

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4.4. Investment in renewable fields

A report indicates that the collective aim of all ASEAN nations is to achieve a renewable energy supply constituting 23% of their overall energy provision [22]. The Asian Development Bank approximates a requirement of $290 billion for attaining this objective. The fiscal circumstances of participating ASEAN countries vary, making such an investment unattainable for every nation within the group. China presently holds the distinction of being the world's primary manufacturer of solar panels, wind turbines, batteries, and electric vehicles. Additionally, for nine of the past ten years, China has ranked as the globe's largest investor in clean energy, as per the Frankfurt School of Finance and Management. Greenpeace's latest research reveals that since 2014, Chinese equity investment alone has supported a cumulative 12,622 MW of wind and solar projects exclusively in South and Southeast Asia [23]. Furthermore, these green investments align significantly with Chinese President Xi Jinping's prominent Belt and Road Initiative due to substantial geostrategic implications. In support of renewable energy projects in Southeast Asia, China's major banks are obligated to furnish preferential loans, with specialized cash pools like the Silk Road Fund currently earmarking tens of billions of dollars [24].

5. Conclusion

The primary direct benefit of carbon neutrality is reflected in the stability of the global climate. By reducing greenhouse gas emissions, especially carbon dioxide, China not only mitigates global warming but also reduces the risk of climate-related natural disasters. In the process of implementing carbon neutrality policies, China has made remarkable achievements and positive contributions to the response to regional and global climate change. At the same time, air quality has improved significantly, with reduced levels of pollutants and particulate matter, especially in large cities, making cities more livable.

Carbon neutrality also promotes the development of a green economy, transforming economies and businesses, creating new jobs, and improving energy efficiency. Reducing reliance on fossil fuels and gradually increasing the use of renewable energy not only improves the country's economic security but also becomes a key driving force for restarting economic recovery in the later stages of the epidemic and creating new economic growth points. Although China faces many challenges in its pursuit of carbon neutrality, such as the pressure to transform traditional high-carbon industries that may lead to unemployment and social instability, the government should remain committed to its environmental policies and goals. China’s leadership in the clean technology market provides huge opportunities for it to become a leader in the global green revolution.

Southeast Asia is one of the most dynamic regions in the global economy. In the ten years before the outbreak of the epidemic, the annual growth rate of per capita GDP remained above 3.5%, which was higher than that of the United States, Japan, and Europe. Although rapid growth has improved people's living standards, it has also brought serious environmental problems. Therefore, ASEAN countries such as Indonesia, Vietnam, and Thailand have made “carbon neutrality” commitments and introduced policies to promote low-carbon transformation. However, these countries still face challenges and lack adequate investment in renewable energy technologies, equipment, and raw materials. China’s experience and cooperation can provide valuable inspiration and strategies for Southeast Asian countries. Carbon neutrality is not only an environmental goal, but should also be integrated with the country's economic and social development strategies, requiring long-term planning and investment from the government. In terms of renewable energy, Southeast Asian countries can alleviate their shortcomings through technical cooperation and trade, as well as increased investment in clean technology research and development and deployment. In the Asia-

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Pacific region, Chinese investment is particularly important for promoting sustainable development. Southeast Asia and China have achieved certain results in achieving carbon neutrality, but there is still much room for improvement in future cooperation. All in all, carbon neutrality is not a simple task, but its long-term benefits far outweigh its short-term costs. Through collective efforts, China can have a profound impact on the environment, economy, and neighboring countries through carbon neutrality, and the country, businesses, and individuals can all benefit from a cleaner and more sustainable future.

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