



Carbon Emission Status and Strategies for Carbon Neutral Targets in China

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Abstract. China has achieved rapid economic growth through opening-up, and in the process of rapid economic growth, China's carbon emissions have significantly increased. During the development of economics, the resources at the disposal of the people have increased, and the related manufacturing and energy industries have developed rapidly, resulting in the massive consumption of traditional energy sources and bringing about huge amounts of carbon emissions and pollutants, which have harmed the environment and the climate. Therefore, this study analyses the current status of carbon emissions in China, reviews the development of carbon neutrality in China in the past few years based on policy guidance, proposes effective pathways to achieve carbon neutrality, and finally predicts the development process of carbon neutrality in China by 2060.

Keywords: Carbon neutralization, energy transformation path, carbon emissions, climate-change policy, policy development.

1 Introduction

Due to the increasing consumption of fossil energy, carbon neutrality is in the spotlight as the significant increase of carbon dioxide emissions. China has pursued industrialization and urbanization policies during the last few years fast economic development, resulting in the largest carbon emitter in the world and account for about 28% carbon emissions of the global carbon emissions in 2019 ^[1]. During the development process of economic, the carbon emissions of China was over than US in 2007, and surpassing 27 countries included UK and European Union countries in 2012, more than 40% dramatically increased carbon emissions from 2007 to 2013, and reaching the highest production of carbon emissions in 2016 ^[2]. In the meantime, large among of carbon emissions are the main component of greenhouse gases. Greenhouse gases mainly contribute to global warming due to carbon dioxide has heat-absorbing and heat-insulating properties and will form a cover like an invisible glass shield in the atmosphere, inhibiting the heat from the earth surface to spread outwards, which leads to climate change and global warming. Hence, it is important to solve the environmental issues by large amounts of carbon emissions in China.

China has realized that the importance of the stabilization of climate related to the carbon emissions. In 2007, China has published The National Climate Change Program and created the China's National Leading Committee on Climate Change to reduce the consumption of fossil fuels energy and increase the amount of consumption in renewable energy. Furthermore, China has taken Nationally Appropriate Mitigation Actions (NAMAs), aiming to reduce around 60% carbon emissions by 2030 compared to the level in 2005. Based on this action, the long-term carbon neutrality aims until to 2060 was proposed in 2020, targeting over 65% reduction of carbon emission by 2030.

To achieve carbon neutrality and reduce carbon emissions in China, the development of technologies in energy conservation and social-economic transitions are needed. The more related policies about carbon neutrality are also encouraged such as launching carbon neutrality pilot projects, applying green energy and recycling use of greenhouse gas emissions. Therefore, this study will introduce the status and effect of carbon emissions in China, related methods, technologies and polices to achieve carbon neutrality and also the proposed further plans.

2 Discussion

2.1 Carbon Emissions in China

The carbon emissions in China was lower 900 than million tons (Mt) before 1970, as the opening-up was proposed and started, the carbon emission has rapidly increased from 1970, and especially with the significant economic raising after China has joined the World Trade Organization (WTO) in 2020 [3]. The increased carbon emissions are due to the industrial structure contains most energy consumption of fossil fuels in China. Coal is the main energy source during the industrialization and urbanization process, China is the largest coal consumption market within the worldwide and account for about half total coal consumptions in the world, and coal energy is producing the around 75% carbon emissions in total carbon emissions in China [4].

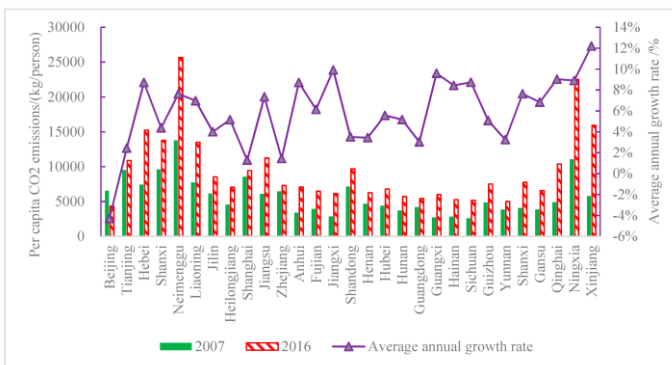


Fig. 1. The carbon emissions of China in each province in 2007 and 2016 [5].

Figure 1 shows the increased carbon emissions from 2007 to 2016 in China with 9 years gap and the difference between different providences. The coastal cities have

higher carbon dioxide emissions, which is related that they have harbors that facilitate the transport of large commodities and goods. Establishing factories and clusters close to ports helps to reduce transport costs and problems such as cooling water and waste discharge required for some technologies. Shandong and Guangdong provinces shows the increased carbon emissions from around 100 Mt to 800 Mt from 1997 to 2017 [3]. However, there are also several inland provinces has raised the carbon emissions such as Inner Mongolia and Hebei provinces. The increase in carbon emissions in the inland provinces is due to large-scale industry, manufacturing, and electricity production. Since China has joined in the WTO, export economics became to the one of the most important contributors to the growth of carbon emissions. In 2009, China has become the largest export trader and reached 1.0 Gt carbon emissions production which double increased from 2000 and accounting almost 10% of total carbon emissions produced [1]. In export trade, China-US trade is another effect factor. Between 2004 and 2017, China and the United States traded is during the conflict, resulting in the related change in trade volumes and amounts and brought the variation in China's carbon dioxide emissions. Some of the goods that the United States imports from China are produced with significant carbon emissions and energy consumption, increasing China's carbon emissions and negatively impacts on China's environment and climate.

C02 Emissions in China-US Trade (2015)

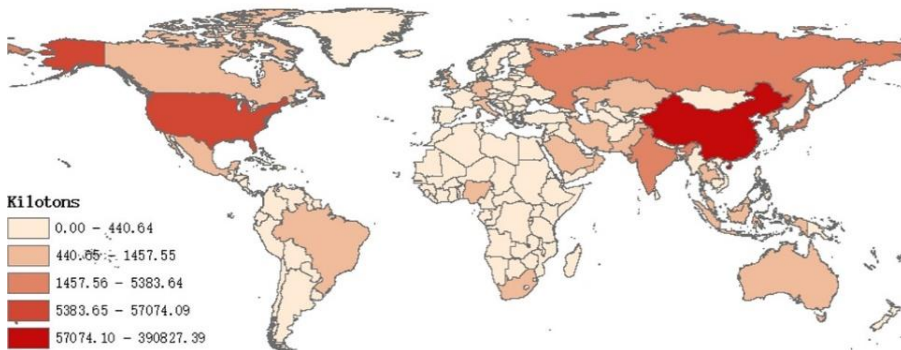


Fig. 2. Produced carbon emissions by China-US trades (unit: Mt) [6].

Figure 2 shows the relationship between China and US by comparing the export trade in carbon emissions, presenting China has more carbon emission within the trade. The amount of carbon emissions from US transferred to China has decreased from 300 Mt in 2004 to 242 Mt in 2017 [7]. However, China continues to be transferred carbon emissions within the China-US trades. Another contributor to the growth of carbon emissions in China is capital investment. From 2002 to 2007, the increased capital investment has produced 944 Mt carbon dioxide in the demands of construction which accounting 68%, 305 Mt carbon emissions in heavy manufacturing industries such as metal production (22%) and about 10% carbon emissions in another field (139Mt) [8]. Due to the significant increased demands in construction and heavy manufacturing industries, the related consumption of energy and industrial materials has increased and leading to the increase of capital investment in total carbon emissions. Moreover, the carbon emissions of capital investment provide 61% and 71% growth in two periods

from 2005 to 2007 and 2007 to 2010 [8]. Another reason of increased carbon emissions is the household and government consumption. Since the opening-up of China, the per capita disposable income of Chinese households has risen dramatically and leading to the higher living standards of household and personal consumption.

2.2 Carbon Neutrality in China

Policy orientation is one of the most important ways to save energy, reduce emissions and achieve carbon neutrality in China. To achieve these goals, Chinese government has closed thousands industry and power generation plants with low energy efficiency and high produced carbon emissions. This operation can save around 750 Mt usages of coal energy source and 1.5 Gt carbon emissions which is around 5% in world carbon emissions [9].

Table 1. Related polices for carbon neutrality in China [3].

Year	Announcement and polices	Time frame	Reduction of pollutant emissions	Increased Forest coverage
2001	The 10th Five-Year Plan	2001–2005	Reduce 10% main pollutant emissions	18.2%
2006	The 11th Five-Year Plan	2006–2010	Reduce 10% main pollutant emissions	20%
2007	Chinese National Climate Change Programme	2005–2010	Reduce 10% main pollutant emissions	20%
2009	Nationally Appropriate Mitigation Actions	2005–2010	Reduce carbon emissions by 40–45% from 2005 levels	40 million hectares
2011	The 12th Five-Year Plan	2011–2015	Reduce carbon emissions by 17% compared to 2010 levels	21.66%
2015	Intended Nationally Determined Contributions	2005–2030	Reduce carbon emissions by 60% compared to 2010 levels	20%
2016	The 13th Five-Year Plan	2016–2020	Reduce carbon emissions by 18% compared to 2015 levels	23.04%
2020	President Xi address at the General Assembly's 75th session	To 2060	Achieve carbon neutrality before 2060	-
2020	Speech of President Xi at Climate Ambition Summit	To 2030	Reduce carbon emissions by 65% compared to 2005 levels	-
2021	The 14th Five-Year Plan	2021–2025	Reduce carbon emissions by 18% compared to 2020 levels	-

Table 1 shows the several policies in these years for carbon neutrality in China. China has published polices to guide the pathways of carbon neutrality, decreasing the carbon emissions and also increasing the forest coverage rate. China's policies have contributed to the reduction of carbon emissions and are approaching carbon neutrality

targets. Through these policies, the carbon emissions have decreased more than 48% in 2019 compared to 2005 and the non-fossil fuel also increased to 15.9%. And the aims of increasing forest coverage have been achieved. From the performance of each province, most provinces have achieved the proposed goals, several provinces even exceed the aims^[3]. Jiangsu province decreased the carbon emissions of 24% compared to 2015 and exceed around 3.5% of the original aims. Yunnan province also exceed about 7% than the proposed goals. However, there are also several provinces, Inner Mongolia did not finish to decrease the 17% carbon emissions, there was 3% gap between the proposed aims and achieved reduction. Due to Inner Mongolia province contains many heavy energy consumption industries and hard to decrease the carbon emissions in short time. Inner Mongolia province is also working on improving energy efficiency and technology to reduce carbon emissions. In the table 1, China is aiming to achieve carbon neutrality by 2060 due to China is the largest contributor to carbon emissions. To achieve this goal, the replacement of coal energy is important. As the demand of electricity, the more power generation plants were constructed, but in coal energy sources, resulting in higher carbon emissions. Hence, the non-fossil fuels are focused and step by step to replace the coal energy. Hydrogen energy, wind energy, solar energy and nuclear energy are belonging to non-fossil fuels. The nuclear energy contains huge potential as a replaced energy resource of coal energy due to the high energy concentrations and very low carbon emissions. The negative emissions are also important in carbon neutrality, decreasing the carbon dioxide from the atmosphere. The afforestation is reported in the Table 1 as mentioned polices. Blue carbon is another method to decrease the carbon emissions by using the salt marshes and seagrass beds to absorb carbon dioxide. Commercial carbon capture and storage technologies are also encouraged to be used in carbon neutrality such as carbonation of cement and Carbonation of cement.

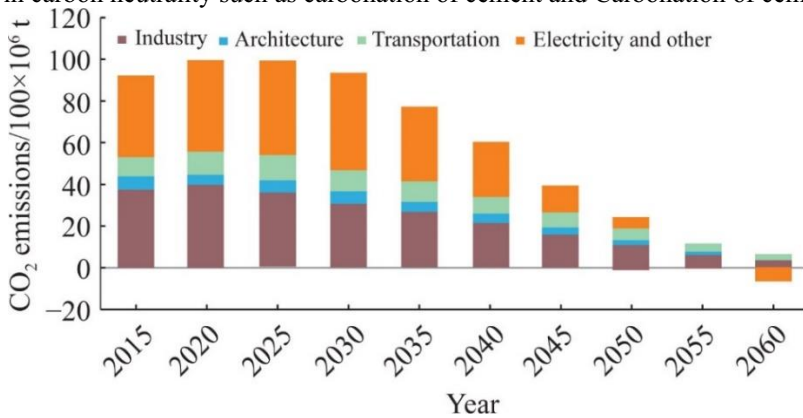


Fig. 3. Prediction of carbon emissions within different fields by carbon neutrality goals to 2060 in China^[10].

Figure 3 has predicted the reduction of carbon emissions in China within industry, architecture, transportation, electricity and other fields. The carbon emissions will reach to peak position in 2025 but starting to decrease in the further years and achieve net emissions by 2060.

3 Conclusion

China accounts for the world's largest carbon emissions and is still rising the rapid economic growth. China's carbon emissions have been gradually increasing since the reform and opening up of China. With the increase in resources at the disposal of the people, the development of China's manufacturing and energy industries has accelerated, but it has increased carbon emissions and pollutants in the process of development, causing harm to the environment and climate. At the same time, the increase in international trade has led countries such as the United States to shift carbon emissions to China. Therefore, in order to reduce carbon emissions and achieve the goal of carbon neutrality, China has continuously published policies to guide industrial upgrading and new technology development to reduce pollutant emissions. To achieve carbon neutrality, the replacement of coal energy, carbon negative technologies and blue carbon technologies contain huge potential. The development of carbon neutrality in China was also predicted to achieve net carbon emissions by 2060.

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