Research on the Compilation of Low Carbon Planning Guidelines for Changxing County, China

Rong Guo, School of Architecture, Harbin Institute of Technology, Key Laboratory of Cold Region Urban and Rural Human Settlement Environment Science and Technology, Ministry of Industry and Information Technology, Harbin 150006, China

Xiaochen Wu, School of Architecture, Harbin Institute of Technology, Key Laboratory of Cold Region Urban and Rural Human Settlement Environment Science and Technology, Ministry of Industry and Information Technology, Harbin 150006, China

Tong Wu, School of Architecture, Harbin Institute of Technology, Key Laboratory of Cold Region Urban and Rural Human Settlement Environment Science and Technology, Ministry of Industry and Information Technology, Harbin 150006, China

Abstract

In the past 40 years since China's reform and opening up, the city has been developing rapidly. Small towns are faced with the challenges of extensive development, degradation of human settlements and difficulty in retaining local characteristics. Therefore, in the development process of small towns, we should not only pay attention to economic development, but also energy conservation and emission reduction, and pay attention to the protection of local characteristics. This paper calculates the carbon emissions of energy consumption in Changxing County from 2002 to 2017, and analyzes the main factors and degree of carbon emissions in Changxing County by using Kaya identities based on the carbon emissions decomposition model. The results show that the carbon emissions of Changxing County increased year by year, but the growth rate showed a downward trend. The effect of economic development and energy intensity has a great contribution to the carbon emissions of Changxing County. Industrial structure effect, energy structure effect and population size effect have little contribution to carbon emissions. Combined with the current situation and main factors of carbon emissions in Changxing County, this paper puts forward the compilation ideas and framework of low-carbon planning guidelines of Changxing County from six characteristic spaces, so as to provide the thinking and practical basis for the low-carbon construction of small towns.

Keywords

Low Carbon, Guidelines, County, China

1.Introduction

With the development of economy, population and economic factors continue to gather in cities. Cities have become the gathering areas of human economic activities and energy consumption. Although the urban area is less than 1% of the earth's surface, it consumes most of the energy and resources and emits 75%-80% of the global greenhouse gases. As a concentrated area of human activities, cities are not only the main source of greenhouse gas emissions, but also vulnerable to the impact of climate change and would be threatened by climate change. In October 2018, the Intergovernmental Panel on Climate Change

(IPCC, 2018) released the *IPCC Special Report on Global Warming of 1.5 degrees Celsius*, pointing out that the current global average temperature has increased by 1 degree compared with the temperature before the Industrial Revolution, and it is likely to reach 1.5 degrees celsius in 2030-2052. The result shows the urgency of tackling climate change to the whole world, reminds countries to firmly transform to green and low-carbon development pattern, and take positive and pragmatic measures to meet the challenges of climate change. In 2016, China's accounted for 27.3% of the world's total carbon emissions, almost twice as much as the second largest emitter, the United States. (BP, 2017; Dong et al., 2018b). However, China is in the period of rapid economic development, with significant differences in the level of cities economic development. But generally, there is a strong demand for industrialization and rapid economic growth.

This paper calculates the carbon emissions of energy consumption in Changxing County from 2002 to 2017, and analyzes the changes of carbon emissions. Moreover, this paper attempts to use decomposition analysis to determine the main factors of carbon emissions. At present, there are two widely used decomposition techniques: structural decomposition analysis (SDA) (Geng et al., 2013; Wang et al., 2013) and exponential decomposition analysis (IDA) (Ang and Zhang, 2000; Ang, 2004). IDA is mainly used to analyze energy consumption and emissions in energy and environmental economics (Fernandez Gonzalez et al., 2014; W. Zhang et al., 2016). SDA is able to decompose the economic and technological effects more accurately (Zhao et al., 2010), which is widely implemented nationwide (Liang et al., 2013; Peters et al., 2007). Research has shown that IDA has less requirements on the amount of data in the decomposition analysis, and can more easily complete the time and space sequence upper decomposition analysis (Liu et al., 2012). In addition, IDA is characterized by index forms, mathematical (addition and multiplication) norms and indices (Hoekstra and van den Bergh, 2002). IDAs are mainly divided into Laspeyres index decomposition and Divisia index decomposition analyses (Ang and Zhang, 2000). Logarithmic mean Divisia index (LMDI) is widely uses because of it compensates the residual problem that other decomposition method could not solve. Besides, it has time reversal and factor reversal properties. LMDI performs well especially when large variations exist in the values of variables, and LMDI can deal with zero values in a dataset compared with other methods (Ang and Zhang, 2000; Ang, 2004). LMDI has become a significant decomposition method in research of carbon emissions. Considering the requirements of existing data and time series, the paper improved the LMDI method to analyze the main factors of carbon emissions in Changxing County.

Zhu Qin et al. (2009) decomposed energy carbon emissions in China into factors such as per capita GDP, population, energy consumption structure, industrial proportion structure, energy consumption intensity and other factors by Kaya model and LMDI method. Ramachandra et al. (2012) analysed the relationship between India's high level of energy consumption and lower per capita emissions. Xu et al. (2012), Fan (2013) and Chong et al. (2015) used the LMDI method to decompose and analyze the driving factors of carbon emissions due to China's energy consumption. Zhang et al. (2017) adopted the LMDI method to do empirical research on carbon emissions in Shaanxi Province. Conducted empirical research; Ma et al. (2019) combines the extended Kaya identity with the logarithmic mean Divisia index (LMDI) decomposition method to analyze the carbon emissions and carbon emission intensity in China, and the results show the rapid economic development and urbanization speed up the carbon emissions.

The paper extends the research to county and takes Changxing county in China as an example, in order to identify the characteristics of carbon emissions in Chinese county and explain the main factors of carbon emissions. The rest of this paper is organized as follows. Section 2 introduces study area and data sources. Section 3 details the carbon emissions related calculation method and decomposition model of carbon emissions factors based on Kaya-LMDI. Section 4 describes the total carbon emissions and carbon emission intensity and then analyzes the main factors of carbon emissions. Finally, shows the consideration of low carbon planning guideline compilation. Section 5 provides the conclusions.

2. Study area and data sources

As shown in Figure 1, Changxing county (between $30^{\circ}43'-31^{\circ}11'N$, $119^{\circ}33'-120^{\circ}06'E$) is located in north of Zhejiang Province, China, with a total area of 1430 km². As of 2018, Changxing County has jurisdiction over 4 subdistricts, 9 towns, and 2 townships, with a total registered population of 636,400, and a gross regional product (GDP) of 60.978 billion yuan. Based on the registered population, the per capita GDP is 95,961 yuan, converted to US\$14,501 at the average exchange rate.

Figure 1. Location of Changxing County. Source: Painted by the author.

To obtain accurate results, 8 fossil fuels are taken into account, including raw coal, coke, natural gas, gasoline, diesel oil, fuel oil, other petroleum products, liquefied petroleum gas, thermal power and electric power. Consumption data and related emission coefficients of these fossil fuels are collected from the China Energy Statistical Yearbooks (2003–2018) and IPCC (2006). To ensure comparability, fossil fuels are converted into standard coal equivalent when calculating the total energy consumption, and the standard coal coefficients for these fossil fuels are also from China Energy Statistical Yearbooks. Data about GDP, total population size in 2002–2017 are derived from Changxing Statistical Yearbooks. To accommodate the price inflation, GDP is normalized at 2001 constant price by using the GDP indices from China Statistical Yearbooks.

3. Methodologies

3.1 Carbon emissions-related calculation method

Carbon emissions from energy consumption are mainly calculated according to the calculation method of carbon emissions proposed by the Intergovernmental Panel on Climate Change (IPCC). This method converts the end consumption of various fossil energy sources into standard coal consumption, then multiplies the standard coal consumption by carbon emissions coefficient, and finally adds up. The formula for calculating carbon emissions is as follows:

$$CE = \sum_{i=1}^{10} EN_i \times EF_i \quad (1)$$

In the formula, CE is the total carbon emissions(t) of various energy consumption; EN_i is the standard coal consumption(t) of type i energy after conversion; EF_i is the carbon emissions coefficient of type i energy; i is the number of energy types. The default values from the IPCC Guidelines for Carbon Emissions Calculations are shown in Table 1. According to the energy statistics of Changxing County, carbon emissions are calculated with ten kinds of energy, such as raw coal and natural gas. Among them, the conversion standard coal coefficient of thermal power is 0.03412kce/million coke, that of electric power is 0.1229kgce/kwh, and the carbon emissions coefficient of coal is 0.7330tc/t.

Table 1 Carbon emissions coefficient of various energy sources

Types of energy	Conversion coefficient of standard coal (t/t)	Carbon emissions coefficient (tCO ₂ /t)
Raw coal	0.7143	0.7559
Coke	0.9714	0.8550
Natural gas	1.3300	0.4483
Gasoline	1.4714	0.5538
Diesel oil	1.4571	0.5921
Fuel oil	1.4286	0.6185
Liquefied petroleum gas	1.7143	0.5042
Other petroleum products	1.4286	0.5860

Source: *China Energy Statistical Yearbooks, IPCC guidelines for national greenhouse gas inventories, National greenhouse gas emission inventory*

3.2 Decomposition model

3.2.1 Kaya identities based on the carbon emissions decomposition model

Kaya identity, which was first proposed by the Japanese scholar (Kaya Yoichi, 1989), has been widely adopted in the fields of carbon emissions, in order to decomposition of GHG. The formula is

$$GHG = \frac{GHG}{TOE} \cdot \frac{TOE}{GDP} \cdot \frac{GDP}{POP} \cdot POP = f \cdot e \cdot g \cdot P \quad (2)$$

where GHG , TOE , GDP and POP represent the total greenhouse gas emissions, primary energy consumption, gross domestic product, and total population of the country, respectively. The three ratios on the right-hand side of the equation (GHG/TOE , TOE/GDP , GDP/POP) represent the energy intensity (f), energy intensity per unit of GDP (e), and per capita GDP (g), respectively. These three factors and the total population constitute the four drivers of carbon emissions.

To better analyze the main factors of carbon dioxide emissions from an energy and sectoral perspective, this paper extends the Kaya identity to the following formula (Johan et al., 2002):

$$\begin{aligned}
 CE &= \sum_{ij} CE_{ij} = \sum_{ij} \frac{GDP_i}{GDP} \cdot \frac{E_i}{GDP_i} \cdot \frac{E_{ij}}{E_i} \cdot \frac{CE_{ij}}{E_{ij}} \cdot \frac{GDP}{P} \cdot P \\
 &= \sum_{ij} IS_i \cdot EI_i \cdot ES_{ij} \cdot CI_{ij} \cdot ED_i \cdot P
 \end{aligned} \quad (3)$$

where CE represents the total carbon emissions, CE_{ij} represents the amount of carbon emissions that the i th sector generates when it consumes the j th energy source, E_{ij} represents the consumption of the j th energy source by the i th sector, E_i represents the total energy consumption of the i th sector, i represents the industry added value of the i th sector, GDP represents the total added value of Changxing's economy, and P represents the total population of Changxing. GDP_i/GDP , E_i/GDP_i , E_{ij}/E_i , CE_{ij}/E_{ij} , GDP/P and P on the right-hand side of the equation above represent the main factors of carbon emissions: industrial structure, energy intensity, energy structure, carbon intensity, economic output and population scale, respectively.

3.2.2. Decomposition model of carbon emissions factors based on Kaya-LMDI

To study the contributions of various factors of carbon emissions, this paper adopts the extended Kaya identity to the LMDI decomposition method and decomposes the factors of carbon emissions to analyze their contributions. The LMDI model contains two calculation methods, "multiplicative decomposition" and "additive decomposition", which are basically the same in the calculation results. Considering the convenience, this paper adopts additive decomposition to decompose the decoupling effect. Assuming that the base period is 0, the total carbon emissions in the base period is CE_0 , the total carbon emissions in period t is CE_t , and the variation in carbon emissions from the base period to period t is ΔCE , then according to formula (3), the total effect of carbon emissions from the base period to period t can be obtained. The formula is as follows:

$$\Delta CE = CE^t - CE^0 = \Delta CE_{IS_{it}} + \Delta CE_{EI_{it}} + \Delta CE_{ES_{ijt}} + \Delta CE_{CI_{ijt}} + \Delta CE_{ED_i} + \Delta CE_{P_t} \quad (4)$$

where ΔCE represents the total effect of carbon emissions decomposition, $\Delta CE_{IS_{it}}$ represents the industrial structure effects, $\Delta CE_{EI_{it}}$ represents the energy intensity effect of the industry, $\Delta CE_{ES_{ijt}}$ represents energy structure effects, $\Delta CE_{CI_{ijt}}$ represents the effect of carbon intensity factors, ΔCE_{ED_i} represents the effect of economic output effect and ΔCE_{P_t} represents the population scale effect. The decomposition results of the effects obtained from the Kaya-LMDI decomposition model are as follows:

$$\Delta CE_{IS_{it}} = \sum_{ij} \frac{CE_{ij}^t - CE_{ij}^0}{\ln CE_{ij}^t - \ln CE_{ij}^0} \ln \left(\frac{IS_i^t}{IS_i^0} \right) \quad (5)$$

$$\Delta CE_{EI_{it}} = \sum_{ij} \frac{CE_{ij}^t - CE_{ij}^0}{\ln CE_{ij}^t - \ln CE_{ij}^0} \ln \left(\frac{EI_i^t}{EI_i^0} \right) \quad (6)$$

$$\Delta CE_{ES_{it}} = \sum_{ij} \frac{CE_{ij}^t - CE_{ij}^0}{\ln CE_{ij}^t - \ln CE_{ij}^0} \ln\left(\frac{ES_i^t}{ES_i^0}\right) \quad (7)$$

$$\Delta CE_{CI_{it}} = \sum_{ij} \frac{CE_{ij}^t - CE_{ij}^0}{\ln CE_{ij}^t - \ln CE_{ij}^0} \ln\left(\frac{CI_i^t}{CI_i^0}\right) \quad (8)$$

$$\Delta CE_{ED_{it}} = \sum_{ij} \frac{CE_{ij}^t - CE_{ij}^0}{\ln CE_{ij}^t - \ln CE_{ij}^0} \ln\left(\frac{ED_i^t}{ED_i^0}\right) \quad (9)$$

$$\Delta CE_{P_{it}} = \sum_{ij} \frac{CE_{ij}^t - CE_{ij}^0}{\ln CE_{ij}^t - \ln CE_{ij}^0} \ln\left(\frac{P_i^t}{P_i^0}\right) \quad (10)$$

Since the annual carbon emissions coefficient does not change significantly, in the calculation, it is assumed that the carbon emissions coefficient remains unchanged. Generally, the carbon emissions coefficient is taken as a constant. When the factor is decomposed, it is 0. Therefore, the carbon intensity effect is not considered as a factor, formula (4) could be simplified as:

$$\Delta CE = \Delta CE_{IS_{it}} + \Delta CE_{EI_{it}} + \Delta CE_{ES_{it}} + \Delta CE_{ED_{it}} + \Delta CE_{P_{it}} \quad (11)$$

4. Discussion

In this section, we discuss the carbon emissions in Changxing County. In [section 4.1](#), we discuss carbon emissions and carbon emission intensity in Changxing County. In [section 4.2](#), we analyze factors of carbon emissions in Changxing County by the decomposition model based on Kaya-LMDI method. Then, in [section 4.3](#), according to the variation in carbon emissions and main factors in Changxing County, we tried to propose a framework for complicating the Changxing County's low-carbon planning guidelines, hoping to guide the construction of low-carbon towns in Changxing County via scientific methods.

4.1. Total amount and carbon intensity of carbon emissions in Changxing County

Total carbon emissions could measure the variation in carbon emissions directly. China is a developing country and has high demand for economic development and industrialization. Therefore, carbon emission intensity is more suitable to describe the carbon emissions variation. Carbon emission intensity refers to the amount of carbon dioxide emissions per unit of GDP, which could better measure the relationship between national or regional economic growth and carbon emissions. If the carbon emission intensity of a country or region shows a downward trend, it indicates that the country or region has achieved low-carbon development or is potential to low-carbon development. Therefore, this section analyzes the variation in carbon emissions in Changxing County from two aspects: total carbon emissions and carbon emission intensity.

According to the calculation results of carbon emissions from energy consumption in Changxing County as shown in [Figure 2](#), as a whole, the carbon emissions have been increasing year by year. The trend could be roughly divided into three stages, the rapid increase stage from 2002 to 2009, decline stage in 2009-2010 and slow increase stage in 2010-2017. The growth rate of carbon emissions has shown a downward trend overall, from the highest 47.9% to 10%. After 2016, the growth rate of carbon emissions has declined, and there may be a slow increase or a downward trend in carbon emissions in the future.

Figure 2. Carbon emissions of Changxing County from 2002 to 2017. Source: Painted by the author.

The variation of carbon emission intensity in Changxing County could be divided into two stages (Figure 3), the increase stage from 2002 to 2006 and the decrease stage from 2007 to 2017. With economic development, carbon emissions per unit of GDP are gradually reduced, and the rate of economic growth is greater than that of carbon emissions (Figure 4).

Figure 3. Carbon emission intensity of Changxing County from 2002 to 2017.

Source: Painted by the author.

Figure 4. Economic growth and carbon emissions in Changxing County from 2002 to 2017.

Source: Painted by the author.

4.2. Decomposition factors of carbon emissions based on Kaya-LMDI model

According to the [formula\(5\)-\(11\)](#), the industrial structure effect, energy intensity effect, energy structure effect, economic development effect, population scale effect and total effect of Changxing County's energy consumption carbon emissions are calculated. The calculation results are shown in [Table 3](#).

Table 3. Decomposition results of carbon emissions factors in Changxing County from 2002 to 2017

	$\Delta CE_{IS_{it}}$	$\Delta CE_{EI_{it}}$	$\Delta CE_{ES_{ijt}}$	ΔCE_{ED_i}	ΔCE_P	ΔCE
2002-2003	11.2249	104.2308	-1.0456	81.1146	-0.4205	195.1042
2003-2004	4.7707	-70.5480	-1.2863	114.9195	0.4139	48.2698
2004-2005	39.5593	128.7161	2.9035	38.1764	-2.1632	207.1921
2005-2006	30.5185	211.8461	-2.6605	186.2020	-3.7887	422.1174
2006-2007	18.6557	-125.1063	-22.4921	210.2920	-0.8253	80.5240
2007-2008	16.3564	-229.5380	1.4645	193.3432	3.9919	-14.3820
2008-2009	-52.2731	-30.2113	-3.9918	104.6148	5.5219	23.6605
2009-2010	-30.3372	-488.9273	-21.7354	189.6467	5.0041	-346.3491
2010-2011	-40.7082	-101.1991	-4.4866	178.6285	5.2430	37.4776
2011-2012	-6.7602	-107.3515	-4.6324	117.2842	-0.1814	-1.6413
2012-2013	-12.7602	-7.2192	-37.3220	112.1895	4.1832	59.0713
2013-2014	6.4237	-0.8248	-32.9942	93.9386	4.7963	71.3396
2014-2015	-36.9335	-15.4500	67.3747	73.4109	-2.4031	85.9990
2015-2016	21.3965	-3.1810	12.8321	141.7054	6.8543	179.6073
2016-2017	-13.6291	-127.1453	-39.0344	129.9063	5.1041	-11.7984
Total effect	-44.4996	-861.9089	-87.9165	1965.3707	31.3307	1003.192

Figure 5. Carbon emission factors in Changxing County from 2002 to 2017. Source: Painted by the author.

It can be seen from Figure 5 that from 2002 to 2008, the contribution of industrial structure to carbon emissions was positive, and from 2009 to 2013 it was negative. The overall cumulative effect on carbon emissions was negative. The industrial structure is the composition of each industry and the proportional relationship between each industry. Different industrial composition and proportional relationship have different effects on economic development and carbon emissions. Revision in the industrial structure has a certain effect on the carbon emissions, which can be explained that the increase in the proportion of the secondary industry could promote the industrial structure effect. Therefore, the way to reduce the effect of the industrial structure is to optimize the industrial structure and weaken the proportion of the secondary industry. The contribution of energy intensity from 2002 to 2017 on carbon emissions is negative. Energy intensity means the input-output characteristics of the energy system through energy consumption per unit of GDP and reflects the overall efficiency of energy economic activities. The decline in energy intensity indicates an improvement in energy efficiency. It is generally believed that the improvement of energy efficiency depends more on technological progress. As energy efficiency increases, carbon emissions decrease, so carbon emissions could be controlled by improving energy efficiency. The overall contribution of energy structure to carbon emissions is negative. Energy structure refers to the composition and proportion of various primary and secondary energy sources in total energy production or total consumption. The situation where coal is the main energy consumption is gradually improving. Therefore, the energy structure can be enhanced by optimizing the energy structure and reducing coal dependence, thereby reducing carbon emissions. GDP per capita is a comprehensive manifestation of the per capita production capacity of services and products in a country or region. It not only reflects the economic development status of the country or region, but also reflects the wealth of residents' material life. The effect of economic development is the main factor in the increase of carbon emissions in Changxing County. Since 2009, the effect of economic development has been decreasing, but among the five main factors, it has still played a major negative effect. The contribution of population scale effects and economic development effects to carbon emissions is positive. The overall contribution of population size to carbon emissions is positive, but the impact on carbon emissions is small. Because the population of Changxing County is small and the population variations are not significant, so the population size has little impact until now. Although the population increases slowly, the demand increases, which in turn promotes an increase in energy consumption and carbon emissions.

According to the historical carbon emissions contribution values of industrial structure effects, energy intensity effects, energy structure effects, economic development effects and population scale effects, the overall contribution of various factors to carbon emissions from 2002 to 2017 is calculated (Table 4). The results show that the cumulative contribution of the population scale effect and economic development effect is positive, and the cumulative contribution of the industrial structure effect, energy intensity effect and energy structure effect is negative. It can be seen that the main driving factors of carbon emissions in Changxing County is economic development, which contributes 3859.65kt to carbon emissions, followed by the population scale effect, which contributes 2.04kt, which is relatively small. The main restraining factors are the energy intensity effect, with a contribution rate of -85.92kt, followed by the energy structure effect and the contribution are -4.32kt and -2.26kt, and the impact is relatively weak. In summary, the reduction of carbon emissions in Changxing County is mainly due to the improvement of energy efficiency, while the industrial structure and energy structure have not brought a significant reduction in carbon emissions. Therefore, the industrial structure and energy structure must be further optimized and upgraded.

Table 4. Carbon emissions contribution rate of decomposition effects

Decomposition effects	ΔCE_{IS_i}	ΔCE_{EI_i}	ΔCE_{ES_i}	ΔCE_{ED_i}	ΔCE_p
Contribution rate	-2.26	-85.92	-4.32	3859.65	2.04

4.3 Consideration of low carbon planning guideline compilation

Most of the low-carbon planning guidelines focus on large cities, which provide guidance on overall urban low-carbon development strategies, low-carbon residential construction, green and low-carbon buildings and so on. There are also guidelines for villages and towns. Although there are few guidelines for county-level cities and towns. With the economic development and industrialization of county-level cities and towns, it is necessary to guide the low-carbon development of such cities. In the compilation of the low-carbon planning guidelines for Changxing County, the paper mainly guided the low-carbon economic development and energy intensity according to the characteristics of carbon emissions and the main factors of carbon emissions, followed by energy structure, industrial structure and population size. Among them, economic development is the main factor affecting carbon emissions in Changxing County, but economic growth is the main goal of urban development. We should develop low-carbon towns and promote low-carbon economic development to reduce carbon emission intensity. Combining the carbon emissions factors as well as space features, it is preliminarily suggested that Changxing County should develop low-carbon towns in six characteristic spaces, including county space, central area, industrial space, residential area, open space and construction site environment. Establish a framework for low-carbon planning guidelines based on the spatial texture of different feature spaces and the factors of carbon emissions (Figure 6.) Based on the study of Changxing County, the guidelines put forward to solve the problem of carbon emissions in a targeted manner, while adopting different carbon reduction methods for different characteristic spaces could protect the characteristic space and texture of towns.

Figure 6. Framework of Low-Carbon Planning Guidelines in Changxing County.

Source: Painted by the author.

5. Conclusion

This paper aims to study the decoupling relationship between economic growth and carbon emissions in Changxing County and the driving factors of carbon emissions, calculate energy consumption carbon emissions from 2002 to 2017. Decompose the driving factors of carbon emissions through the Kaya-LMDI model, and analyze the effect of each factor on carbon emissions. The research conclusions obtained in this paper are as follows:

Carbon emissions are increasing year by year, but the growth rate is gradually decreasing. With the development of the local economy and the introduction of emission reduction technologies, the intensity of carbon emissions has been decreasing year after year, indicating that the amount of carbon dioxide emitted per unit of GDP in Changxing County is gradually decreasing, which is in line with the national requirements for reducing carbon dioxide emissions per unit of GDP. It shows that Changxing County has implemented energy-saving and emission-reduction measures and environmental control policies during the "Eleventh Five-Year", "Twelfth Five-Year" and "Thirteenth Five-Year" periods. The dependence of economic development on energy is gradually weakening. The energy structure is the main factor in restraining carbon emissions, and the restraining effect remains increasing. Industrial structure and energy intensity also play a more important role in curbing carbon emissions. The reason for the transformation of carbon emissions is the optimization of the energy structure and industrial structure, as well as the improvement of energy intensity. In addition, economic development and population size are the main factors contributing to the growth of carbon emissions.

Based on the above conclusions, in order to promote the development of a low-carbon economy in Changxing County, carbon emissions control and economic development should be synchronized and coordinated. (1) Optimize the industrial structure and reduce the proportion of the secondary industry. The increase in the proportion of the secondary industry will increase the industrial structure effect. The main industry that promotes carbon emissions is the secondary industry. Therefore, in controlling carbon emissions development in the future, active measures should be taken to promote low-carbon and green secondary industry, introduce advanced technologies to replace traditional technologies in order to reduce carbon emissions from the secondary industry. At the same time, reduce the proportion of the secondary industry, vigorously develop the tertiary industry, and rationally optimize the industrial structure. (2) Adjust the energy structure and replace traditional energy with clean energy. New energy can be introduced in future to replace traditional energy and optimize the energy structure. (3) Improve energy intensity and improve energy utilization efficiency. Changxing County has made great progress in energy efficiency, but there is still potential for improvement. Enterprises should adopt new technologies and equipment under the guidance of the government to further improve energy efficiency. (4) Control the population at a reasonably size and popularize low-carbon awareness. The population change in Changxing County is relatively small, and its impact on carbon emissions is relatively weak. With the advancement of the talent introduction policy, the population is bound to increase. Therefore, the government should control the population size according to its own conditions, and popularize low-carbon knowledge to promote low-carbon life, and advocate low-carbon behaviors to residents. (5).The government could complicate low-carbon planning guidelines based on development conditions and local characteristics to direct low-carbon construction while protecting traditional features and cultural resources. When planning new residential areas, low-carbon spatial layout and energy-saving and environmentally-friendly building materials could be used. Promote the construction of green public buildings and promote the use of shared bicycles and new energy vehicles as well as other carbon reduction ways to achieve the aim of low-carbon development in Changxing County as soon as possible.

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