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A review of the Spatial and Temporal Evolution of Carbon Emissions and Emission Reduction Potential in the Power Industry

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ABSTRACT

The situation of global warming is becoming more and more serious. As an important field of total carbon emission control, it is of great significance to study the power industry for achieving global climate goals and sustainable development. Firstly, the related concepts of carbon emissions, carbon peaking, carbon neutralization and emission reduction potential in the power industry are introduced. Secondly, from the international and domestic perspectives, the latest research progress of carbon emissions accounting, carbon emissions influencing factors, carbon emissions prediction and emission reduction potential in the power industry are summarized and sorted out. Finally, the existing research on carbon emissions in the power industry is analyzed from four aspects.

KEYWORDS

Power industry; Carbon emissions; Influencing factors; Forecasting; Emission reduction potential

1. INTRODUCTION

Compared with the 19 th century, the global temperature increased by 0.4 ~ 0.6°C at the end of the 20 th century. The United Nations Committee of Experts on Climate Change proposed a global climate change threshold of 2°C. If the world continues to follow the current development model, the global average temperature will rise by 4 ~ 6°C in the 21 st century, which is 6 ~ 10 times that of the 20 th century. Global warming will bring a range of hazards, such as rising sea levels, melting glaciers, warming and acidification of the oceans, more frequent flash floods, mudslides, glacier collapses, and extreme weather, triggering a series of economic and political conflicts. As of July 2017, the average Arctic sea ice area is only 7.9 million square kilometers, a decrease of 23.45% from the 1992 average. The rate of sea level rise in the past 50 years is about 1.0 ~ 2.5 mm / year. With global warming, sea level will continue to rise in the next 50 ~ 100 years, and will rise by about 25 ~ 30 cm by 2050. The increase of greenhouse gas emissions is the root cause of the sharp rise in global temperature. The greenhouse gas emissions caused by human activities are considered to be the most important contributors. Among them, the greenhouse gases produced by human beings are mainly carbon dioxide and other gases produced by fossil fuel combustion. The sixth assessment report of the United Nations Panel on Climate Change (IPCC) in August 2021 states that global carbon dioxide concentrations in 2019 were at least higher than at any time in two million years. At present, climate warming has become the focus of world attention, which is related to the survival and sustainable development of all mankind. Countries around the world have basically reached an agreement on climate change. On December 2015, the ' Paris Agreement ' on global warming came into effect. The main objective of the agreement is to control the increase of global average temperature in this century within 2°C, and to control the increase of global temperature within 1.5°C above the level of preindustrial period. At the same time, in response to the critical issue of global climate change, countries are actively taking countermeasures, setting carbon emission reduction targets such as carbon neutrality, climate neutrality and net zero emissions. Among them, 66 countries, including Singapore, the United States, Japan and Australia, have made commitments to achieve net zero emissions by 2050.

In 2017, China 's total carbon emissions accounted for 27.2% of the total global carbon emissions, ranking first in the world. According to BP, in 2020, China 's total carbon emissions are 31.8% of the world 's total carbon emissions. The International Energy Agency predicts that China 's energy-related carbon dioxide emissions will rise to 11.615 billion tons in 2030, an increase of 48.6% of the total global carbon emissions during the period from 2007 to 2030. As the world 's second largest energy consumer and the largest greenhouse gas emitter, in recent years, in order to actively respond to global warming and fulfill the responsibility of carbon emission reduction, China has successively formulated carbon emission reduction targets and policies. In November 2014, China pledged in the " Sino-US Joint Statement on Climate Change " that carbon dioxide emissions will peak around 2030 and strive to peak early. In addition, non-fossil energy will account for about 20% of primary energy consumption. In July 2020, China 's " 14th Five-Year Plan " pointed out that it is necessary to accelerate the progress towards green and low-carbon development. In September of the same year, China announced to the world at the general debate of the seventy-fifth session of the United Nations General Assembly that it would increase its national independent contribution and adopt stronger policies and measures to reduce carbon dioxide emissions by 2030.In October 2021, China issued the " Opinions on Completely, Accurately and Fully Implementing the New Development Concept and Doing a Good Job in Carbon Neutralization of Carbon Peaks, " which clearly stated that carbon peak will be achieved by 2030, the proportion of non-fossil energy consumption will reach about 25%, and carbon dioxide emissions per unit of GDP will decrease by more than 65% compared with 2005 ; by 2060, carbon neutrality will be achieved and the proportion of non-fossil energy consumption will reach more than 80%. China 's commitment to achieve carbon peak and carbon neutrality highlights China 's action in the face of climate change and the image of great power responsibility. It has set a positive example for the global response to climate change and has received extensive attention and appreciation from the international community. However, China 's commitment to peak carbon emissions will bring great pressure and challenges to domestic energy and industrial restructuring, including the synergy and trade-off between economic, energy and technological factors. Therefore, low-carbon emission reduction has become the development direction of all walks of life in China.

Although all industries are responsible for achieving carbon emission reduction targets, with the steady development of economic recovery in the post-epidemic era and the approaching trend of electrification, electricity demand has grown rapidly under the stimulation of the whole society. In 2021, China 's total electricity consumption will increase by 1% year-on-year, of which 56% of the new electricity demand will be filled by coal power. As the basis of China 's economic development, the power industry 's energy consumption accounts for an increasing proportion of total energy consumption. In 2022, the proportion of non-fossil energy in the energy consumption structure of the power industry is 36.2%. Since 2010, although China 's new energy power generation such as hydropower, nuclear energy, wind energy, and solar energy has developed rapidly, it has gradually become a new force that can replace thermal power due to its pollution-free and environmentally friendly characteristics. However, China 's resource endowment determines that the power generation structure of China 's power industry will still be dominated by thermal power generation, which mainly depends on the use of coal. According to the " Research on the Carbon Neutralization Development Path of Carbon Reaching Peak in the Power Industry " released by the China Electric Power Enterprise Federation in December 2021, the carbon emissions of the power industry, transportation industry, construction industry and industry in 2019 accounted for 41%, 28% and 31% of China 's total carbon dioxide emissions, respectively. Therefore, the carbon emissions of the power industry is a part of China 's total carbon emissions can not be ignored. The 2016 ' Clean Energy Blue Book ' pointed out that China 's power industry is an important area of carbon emission and carbon emission reduction. The report believes that China 's installed power generation capacity has surpassed the United States to rank first in the world, and is also the world 's largest coal-fired power generation country. It has great potential for carbon reduction and can achieve decarbonization faster. Therefore, effective control of carbon emissions in the power industry will become an important way to achieve China 's carbon emission reduction targets. This paper first introduces the concepts of carbon emission, carbon peak, carbon neutralization and emission reduction potential in the power industry. On this basis, it systematically sorts out the existing research on carbon emission accounting, influencing factors, prediction and emission reduction potential in the power industry. Finally, it puts forward suggestions and prospects for further research on the spatial and temporal evolution of carbon emission and emission reduction potential in the power industry.

2. CORRELATIVE CONCEPT

2.1. Power Industry Carbon Emissions

The electric power industry refers to the general term of relevant equipment, technology, services and business activities including power generation, transmission, distribution and power supply. The industry mainly involves the activities of power generation, power transmission and distribution, power equipment manufacturing and operation. The core business of the power industry is to convert various energy sources (such as fossil energy, nuclear energy, etc.) into electrical energy and transmit it to the user terminal to meet the power needs of social production and life. The main source of carbon emissions is energy consumption. Therefore, the carbon emissions of the power industry are generated by power generation. According to the different energy structure of power generation, it is mainly divided into thermal power, wind power, hydropower and nuclear power. Among them, wind power, thermal power and nuclear power do not consume fossil fuels, so they almost do not produce atmospheric pollutants. Coal, fossil fuels, oil and other fossil energy consumed by thermal power generation in the combustion process will cause air pollution, so thermal power generation has become the main source of air pollutant emissions in the power industry, and also the main source of carbon emissions.

2.2. Carbon Peak and Carbon Neutralization

Carbon peak refers to the annual carbon emissions generated by human economic activities in a country or region reach the highest value in history, and experience a process of continuous decline after the platform period, which is the historical inflection point of carbon emissions from increase to decrease. Carbon neutrality refers to the total amount of greenhouse gas emissions directly or indirectly generated by a country or region in a certain period of time. Through afforestation, carbon capture and utilization, storage and other technical means, it can offset its own greenhouse gas emissions and achieve ' zero emissions '. Carbon peaking is the basis and premise of carbon neutrality. Only by achieving carbon peaking can carbon neutrality be achieved. The time and peak value of carbon peak directly affect the duration and difficulty of carbon neutralization. The earlier the carbon peak is reached, the lower the peak is, the greater the space and flexibility to achieve carbon neutralization, and the less difficult it is. The later the carbon reaches the peak and the higher the peak, the faster and more difficult it is to achieve the technological progress and development model transformation required by carbon neutrality. Carbon peak is a tool, and carbon neutralization is the ultimate goal. Carbon neutrality is a tight constraint on carbon peak, and the carbon peak action plan should be formulated under the guidance of achieving carbon neutrality. Double carbon is the abbreviation of carbon peak and carbon neutralization.

2.3. Emission Reduction Potential

Emission reduction is the goal and result. It refers to reducing pollutant emissions by improving energy efficiency through technological innovation and management innovation. Potential refers to the potential ability and power existing in the interior of things that have not yet been revealed. The emission reduction potential refers to the untapped emission reduction capacity existing in a certain carbon emission subject, that is, the further downward trend that may exist in energy consumption and carbon emissions. Combined with the research object of this paper, the emission reduction potential of the power industry is the unit value added energy consumption and unit value added emission two indicators to measure the emission reduction status of the power industry, whether there is a further downward trend in the future. In order to be able to quantify the expression, this paper further defines the emission reduction potential as a set of factors that affect the growth of carbon emissions based on specific future development goals. The difference between the carbon emissions generated by the development of the power industry in accordance with this path and the carbon emissions generated by the original development path or model of the economy and society without design.

3. RESEARCH STATUS OF CARBON EMISSIONS IN POWER INDUSTRY

In view of the related problems of carbon emissions in the power industry, scholars at home and abroad have carried out a series of studies and achieved certain results. The author sorts out the research on carbon emissions in the power industry, and sorts out and summarizes the research from four aspects : carbon emission accounting in the power industry, carbon emission influencing factors in the power industry, carbon emission prediction in the power industry, and emission reduction potential in the power industry.

3.1. Research Overview of Carbon Emission Accounting in Power Industry

At present, foreign scholars ' research on carbon emissions in the power industry is mainly carried out at the global, national and municipal levels. At the global level, Shrestha et al. [1] analyzed the evolution of SO2 emission intensity in the power sector of 12 Asian economies from 1980 to 1994. At the national level, Reema [2] analyzed the trend of carbon emissions from power generation in Saudi Arabia from 1980 to 2017 by using a structural time series model. Blizniukova et al. [3] carried out research in Germany, emphasizing that due to the short-term variability of renewable energy, electricity greenhouse gas emissions are also volatile. Therefore, these fluctuations can be captured by increasing the time resolution when calculating electricity emissions. At the municipal level, Gour et al. [4] discussed how to improve the ability to cope with carbon emissions while establishing coal-fired power plants by calculating the approximate carbon emissions of power plants and the carbon tolerance level of the city where the power plant is located.

Different from foreign countries, China 's research on carbon emissions in the power industry is mainly based on regions, provinces or prefecture-level cities. At the regional level, the research on carbon emissions in the power industry can be roughly divided into two categories: one is to directly use the country 's division of major regions, such as Guo Yi et al. [5]. The IPCC inventory method and network method are used to calculate the carbon emissions in the process of power production, transmission and consumption in the Yangtze River Economic Belt from 2005 to 2020, and analyze its spatial and temporal differentiation characteristics based on regional and industrial levels. The other is to re-divide the region based on the calculated results. At the provincial level, Li Mingyu et al. [6] conducted carbon emission accounting and emission concentration analysis of China 's electric power based on enterprise sample data and provincial database. The results show that the carbon emissions of the power industry in 15 provinces are still growing rapidly; the carbon emissions of the power industry show the characteristics of 'high in the east and low in the west'. Based on the panel data of 30 provinces in China from 2000 to 2019, Sun et al. [7] calculated and analyzed the carbon emission intensity of China 's provincial power generation and its spatial distribution characteristics. It was also found that the carbon emission intensity of power generation showed a spatial distribution pattern of high in the northeast and low in the southwest. At the municipal level, Liu et al. [8] used the data of 286 prefecture-level cities in China to visualize the dynamic changes of the focus of electricity consumption from 2004 to 2016.

3.2. Research on the Influencing Factors of Carbon Emissions in the Power Industry

With the gradual improvement of carbon emissions accounting in the power industry, many foreign scholars have joined the research team on the influencing factors of carbon emissions in the power industry. The factors affecting carbon emissions in the power industry mainly focus on factors such as economy, technology, output structure, fossil fuel consumption, and power efficiency. Shakila et al. [9] believe that the power sector is the largest source of carbon dioxide emissions, and it is necessary to study the potential factors of changes in carbon dioxide emissions in the power sector. Therefore, Shakila et al. [9] explored the impact of population growth, economy and energy technology on carbon dioxide, methane and nitrous oxide emissions in Bangladesh 's power sector from 1995 to 2014.Rodrigues et al. [10] found that the change of fossil fuels (replacing coal with natural gas) was the main driving factor for the reduction of carbon emissions of EU power generation enterprises from 2000 to 2007 by quantitatively evaluating the factors affecting the carbon emissions of EU power generation enterprises in the two periods of 2000-2007 and 2007-2015.In addition, the efficiency of electric energy use was improved. The main driving factors for the reduction of carbon emissions of EU power generation enterprises from 2007 to 2015 are the expansion of renewable energy power, the improvement of fossil energy power production efficiency and power use efficiency, and there are significant differences in the driving factors of carbon emissions changes of power generation enterprises in various countries.

In recent years, many domestic scholars have used factor decomposition method to study the influencing factors of carbon emissions in the power industry. Factor decomposition method is to decompose the change of the research object in a period into several driving factors, which can study the change characteristics and mechanism of things. Due to the wide adaptability and strong persuasion of this method, domestic scholars are increasingly inclined to choose factor decomposition method in the analysis of the interaction between energy, economy and environment. At present, the main factor decomposition method in China is exponential decomposition method, such as logarithmic mean Divisia index decomposition method (LMDI) and generalized Divisia index decomposition method (GDIM). Among them, because the residual error generated by the LMDI decomposition method after decomposition is 0, there is no requirement for data. Therefore, the LMDI decomposition method is widely used in the analysis of the influencing factors of carbon emissions in the power industry. Based on the principle of consumer responsibility, Chen Guijing et al. [11] used LMDI to analyze the main factors affecting the difference of CO2 emissions in the power industry in Beijing-Tianjin-Hebei region from the perspectives of production side and consumption side.Guo Yi et al. [5] took the power industry in the Yangtze River Economic Belt as the research object, and comprehensively used the IPCC inventory compilation method, network method and LMDI method to explore the different influencing factors of carbon emission changes in regional power production and consumption. However, the LMDI decomposition method still has some shortcomings. It can only consider the role of direct influencing factors and cannot consider the problem of indirect factors. The GDIM decomposition method proposed by Vaninsky [12-13] can quantify the influence of multiple absolute and relative factors on the target variables at the same time. Therefore, some scholars tend to choose the GDIM decomposition method to analyze the influencing factors of carbon emissions in the power industry. Yong et al. [14] used the GDIM model to decompose the carbon emissions of the power sector in eight regions of China, and compared the driving factors of carbon emissions in the power sector in each region and their degree of influence.

The results show that GDP and output scale are the main contributors to the carbon emissions of the power sector in the eight regions. Economic carbon intensity and output carbon intensity are the main factors to promote emission reduction.Yin et al. [15] analyzed the impact of four absolute factors, namely, economic scale, energy consumption scale, population scale and output scale, on the carbon emissions of the power industry in the Yangtze River Economic Belt and its upper, middle and lower reaches by constructing a GDIM decomposition model. The research shows that the scale of economy, output and energy consumption is the main factor leading to the increase of carbon emissions in the Yangtze River Economic Belt and the upper, middle and lower reaches, while carbon intensity and output carbon intensity are the key factors to curb carbon emissions. Among them, economic scale is the largest positive driver of carbon emissions in the middle and lower reaches, and output carbon intensity is the largest negative driver in the upper reaches. In addition, some scholars have used other methods to study the influencing factors of carbon emissions in the power industry. For example, Sun et al. [16] used the spatial Dubin model to calculate the spatial spillover effect of each driving factor on carbon emissions in the power industry. It is calculated that economic development and foreign trade both inhibit carbon emissions in the power industry, while electricity consumption, R & D and power structure all promote carbon emissions in the power industry. There is a spatial spillover effect on the impact of various driving factors on carbon emissions in the regional power industry.

3.3. Overview of Carbon Emission Prediction Research in Power Industry

In the early days, foreign scholars mainly predicted the trend of carbon emissions in power systems from the perspective of marginal emission coefficients. For example, Hawkes [17] first estimated the short-term marginal emission coefficient of the UK power system, and then proposed the concept of long-term marginal emission coefficient, and then established and applied a new power system model to study the future trend of long-term marginal emission coefficient. It is found that the average long-term marginal emission coefficient of the UK power system in the next decade is about 0.26 ~ 0.53kgCO2 / kWh, but with the decarbonization of the power system, the long-term marginal emission coefficient will drop to about zero by 2035 and beyond. With the deepening of the research on carbon emission prediction in the power industry, many scholars have begun to use scenario analysis to predict carbon emissions in the power industry. For example, Veselov et al. [18] elaborated and compared the development scenarios of Russia 's power industry in two different scenarios by 2050.Unlike most predictive assessments, the purpose of this study is to estimate the possibility of realizing the low-carbon transformation of Russia 's power industry technology and the resulting economic consequences.Sabeti et al. [19] developed and analyzed realistic strategies to improve the economic and environmental efficiency of Iran 's power plants by designing evolving economies and seven other different scenarios to study power plant management methods that combine the supply side and the demand side.

Domestic scholars have used a variety of prediction methods to predict carbon emissions in the power industry, including quantitative analysis methods such as system dynamics models, support vector machine regression (SVR) and Monte Carlo simulation techniques, STIRPAT models, and scenario analysis methods. For example, Wang Xiping and Wang Yueyue [20] simulated and predicted the carbon emissions of China 's power industry from 2005 to 2030 by constructing a system dynamics model and setting three scenarios of benchmark, low carbon and ultra-low carbon. Yu et al. [21] used support vector machine regression (SVR) and Monte Carlo simulation techniques to predict electricity demand and carbon emissions under four scenarios with different carbon emission permits and carbon emission reduction levels. Among them, carbon emission prediction based on STIRPAT model is the mainstream research method for carbon emission prediction and analysis. Ding Tiantian and Li Wei [22] According to the effect of nine influencing factors of carbon emissions in China 's power industry from 2000 to 2015, nine different scenarios were set up by scenario analysis method, and STIRPAT model was used to predict and analyze the peak value of power carbon under different scenarios.Wang et al. [23] also used the STIRPAT model and improved it, and then combined the ridge regression algorithm to perform biased estimation analysis on historical data, so as to establish a carbon emission prediction model of Shanghai electric energy based on elastic relationship. Moreover, according to the Shanghai 's ' 14th Five-Year ' development plan, the parameters affecting the carbon emissions of the power industry are predicted and analyzed. In addition, some scholars use scenario analysis to predict the carbon emissions of the power industry. Chen et al. [24] comprehensively evaluated the trend of carbon emissions from energy activities in China 's power industry by 2035 under the conditions of existing policies and strengthened policies. It is found that under the existing policy scenarios, the carbon emissions of the power industry will peak around 2030, and by strengthening the relevant policies to promote the green and low-carbon development of energy, the carbon emissions of the power industry will peak before 2025. Wang Lijuan et al. [25] considered factors such as social and economic development, electricity demand of various departments, power supply structure adjustment, and changes in standard coal consumption of power generation. Based on the scenario analysis method, the carbon emission trend prediction of the power industry was carried out to identify the main driving factors of carbon emission reduction.Liu et al. [26] studied the emission reduction transformation path of China 's power industry. Firstly, we assume several boundary conditions for the power structure conversion considering the future electricity consumption of the whole society. Secondly, a transformation path optimization model with the minimum total cost of the power industry as the goal is established. Finally, according to the optimization results, the transformation forecast of the power industry under the ' 30·60 scenario ' is analyzed in detail.

3.4. Research Overview of Carbon Emission Reduction Potential in Power Industry

Foreign research on the carbon emission reduction potential of the power industry is mainly divided into two categories : one is to study the carbon emission reduction potential under different development scenarios. In the study of the carbon emission reduction potential of the power industry under four different scenarios, such as Ari et al. (2011) [27], it is shown that reducing the share of fossil fuel power plants can indeed significantly reduce the carbon emissions of the power industry. The other is to study the carbon emission reduction potential brought by the independent action of factors such as power structure, emission reduction technology application or a certain emission reduction policy. Kokou et al. [28], based on the system dynamics method, evaluated the impact of energy efficiency of urban residents in the Togolese capital on electricity consumption and carbon dioxide emission reduction from 2000 to 2050. Vahid et al. [29] studied whether the use of battery storage systems to minimize electricity costs will lead to the minimization of emissions under the existing electricity price structure of the consumer 's location. The results show that emission reduction is indeed at the expense of increased costs.

At present, domestic scholars mainly use different emission reduction potential models, as well as different carbon emission calculation models combined with scenario analysis to measure the emission reduction trend and potential of the power industry. In terms of the construction of emission reduction potential model, Huo et al. (2014) [30] established a technical emission reduction calculation method and formula, and set up planning scenarios and strengthening scenarios according to the latest planning and technology application potential evaluation system, analyzed the carbon emission reduction potential of power production from bottom to top and identified key emission reduction technologies, and understood the impact of technological progress uncertainty on carbon emission reduction potential. In addition, some scholars combine different carbon emission accounting models with scenario analysis to study the emission reduction potential of carbon emissions in the power industry. Chen et al. [24] used the learning curve tool to study the development of other types of power sources by means of non-bottom-up technical accounting. On this basis, the power generation structure and carbon emission reduction potential of China 's power industry before 2035 were analyzed. Li et al. [31] combined the existing and strengthened policy scenarios under the strategic goal of carbon emission reduction, predicted the electricity demand based on the elasticity coefficient method, and measured the emission of air pollutants and emission reduction potential of thermal power under different pollutant emission standards.Chen et al. [32] used scenario analysis method to comprehensively consider the impact of technological progress, local policies and planning on carbon emission reduction of power grid enterprises. Based on LEAP model, the carbon emissions of power grid enterprises under different scenarios were calculated, and the contribution of different emission reduction scenarios to carbon emission reduction was analyzed, so as to provide reference for provincial power grid enterprises to scientifically formulate enterprise emission reduction plans.

4. LITERATURE SURVEY

Foreign research on carbon emissions in the power industry started earlier, but its research is more focused on a foreign country and a region, lacking specific targeted research on carbon emissions in the power industry in China and various regions of China, and cannot be directly applied to China 's national conditions. Although the research on carbon emissions in the power industry started late in China, with the increasing investment and attention of the state in the power industry in recent years, the research on carbon emissions in the power industry has continued to deepen. From the initial reference to foreign research results, to the present stage based on the domestic, combined with the actual situation in China, to study the carbon emissions of China 's power industry. Based on the above research status, many scholars at home and abroad have made a lot of achievements in the research of carbon emissions in the power industry, and there is still some room for improvement.

4.1. Carbon Emission Accounting of Electric Power Industry

Scholars at home and abroad have made some achievements in the research of carbon emission measurement methods in the power industry. Most scholars generally use the algorithm recommended by IPCC to measure the carbon emissions of the power industry. While constantly improving the measurement methods, scholars have also analyzed the spatial and temporal evolution characteristics of carbon emissions in the power industry more deeply. At present, the research of domestic and foreign researchers in this field focuses on a specific level. However, in fact, the study of carbon emissions in the power industry in all regions is helpful to clarify the spatial and temporal dynamic evolution of carbon emissions in the power industry in various regions, so as to better understand the spatial and temporal pattern of carbon emissions in China 's power industry, which is of great significance to the formulation of carbon emission reduction policies in the power industry. At the same time, at present, most of the research on carbon emissions in the power industry from the regional level is directly used to facilitate the division of major regions by the state for administrative management. However, China has a vast territory and different resource endowments. There are great differences in the structure of power supply and demand and the characteristics of carbon emissions, which is not suitable for the traditional administrative division method.

4.2. Influencing Factors of Carbon Emissions in the Power Industry

At present, most scholars at home and abroad use the logarithmic mean Divisia decomposition method (LMDI) to explore the driving factors and the degree of action behind the carbon emissions of the power industry. However, in the LMDI decomposition method, each factor is in the form of multiplication, and there is a correlation between each factor. The decomposition result is also affected by the selected influencing factors, which may lead to the opposite conclusion. This also makes the relevant research, the influence factor index may exist in the selection is not comprehensive enough, the conclusion is biased. In addition, most of the research is focused on the power industry in China as a whole and in individual regions and some provinces. However, analyzing the driving factors behind the carbon emissions of the power industry in all regions of China is conducive to governments and power companies at all levels to formulate practical and feasible carbon reduction and pollution reduction plans for the power industry on the basis of increasing power supply.

4.3. Prediction of Carbon Emissions in the Power Industry

On the one hand, in the choice of research methods, the academic community mainly uses scenario simulation methods to predict the future trend of carbon emissions in the power industry under different scenarios. However, most scholars directly use the prediction results of other scholars on this indicator when setting scenario prediction parameters, without considering the actual situation of the current time node. On the other hand, in terms of research perspective, the current academic community focuses on the study of the carbon peak of the national overall power industry when studying the carbon peak of the power industry. However, the scientific prediction of carbon emissions in the power industry from a regional perspective is helpful to provide theoretical basis and policy enlightenment for the carbon emission control of the regional power industry.

4.4. Carbon Emission Reduction Potential of Electric Power Industry

At present, domestic and foreign scholars ' research on the carbon emission reduction potential of the power industry is roughly divided into the following two categories: one is to study and design the carbon emission reduction potential brought by the independent action of low-carbon power generation technology, power structure or a certain emission reduction policy from a micro perspective. This kind of research can well quantify the emission reduction potential of a certain factor, but it is difficult to analyze the overall emission reduction potential of the power industry from an overall and macro perspective. The other is to set up a comprehensive scenario for the future. By referring to the low-carbon policies, development plans and advanced technologies of the country and industry, a series of scenarios of possible economic structure, technical level and energy efficiency in the future are constructed, and the carbon emission reduction potential under various development scenarios is discussed.

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