

Research on College Students' Awareness Level for Low-carbon Campuses Development under Dual Carbon Goal

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Abstract: Low carbon development is an important strategic measure for the global response to climate change. As important members of society, college students should actively participate in the dual carbon reduction action. Based on the collection of 3048 questionnaires, the main research objects were college students in Shenzhen. The cognitive level of low-carbon development and low-carbon campus construction among college students was analyzed from three aspects: the concept and goals of low-carbon development, the measures taken by the school in low-carbon campus construction, and the construction of low-carbon campus education. The research conclusion is that 68.11% of college students are relatively familiar or very familiar with the concept of "dual carbon", 78.44% of college students believe that low-carbon development can simultaneously improve energy utilization efficiency, reduce greenhouse gas emissions, promote economic development, and protect the ecological environment. 78.28% of college students believe that individuals should pay attention to low-carbon lifestyles, participate in low-carbon technological innovation, and pay attention to and support low-carbon policies in low-carbon development, 92.39% of respondents believe that low-carbon education plays an important role in higher education. Therefore, schools should attach importance to the importance of low-carbon campus education in promoting low-carbon development and achieving the "dual carbon" goals, and propose research directions and suggestions for future low-carbon campus education.

Keywords: Carbon emissions; Carbon neutrality; College students; Low carbon development; Low carbon campus

1. Introduction

With the increasingly serious global climate change issue, low-carbon development has become an important strategy for China to address climate change. Climate change has become a global issue threatening human survival and development, and CO₂ emissions caused by the extensive use of fossil fuels are the main cause of global climate change. Therefore, energy conservation and emission reduction for sustainable development has become a common goal of countries around the world. As the world's largest developing country, China surpassed the United States to become the world's largest energy consumer and carbon emitter in 2006. Details as showed in table 1 for the CO₂ emissions of China ^[1-2].

Table 1: China's main commitments in energy conservation and emission reduction

time	Main commitments
2020	Carbon intensity decreased to 40-45% in 2005 and 17% in 2010
2030	65% reduction in carbon intensity
2030	Strive to achieve carbon peak
2030	The proportion of non fossil fuels reaches 25%
2060	Strive to achieve carbon neutrality

Data source: White paper of China's Energy Development in the New Era

Shenzhen, as a core city of the Special Economic Zone, the Guangdong Hong Kong Macao Greater Bay Area, and a socialist demonstration zone, is one of the first low-carbon pilot cities in China, bearing significant expectations and responsibilities. As a member of society, college students should actively participate in the "dual carbon" emission reduction action. According to 2021 statistics, there are 529,300 schools of all levels and 291 million students in China. As the most active place for scientific research and education, China's universities have more than 41.83 million students, which exceeds the total population of many countries, and are the group with the most energy consumption capacity and huge

potential for energy conservation and emission reduction, shouldering the responsibility and obligation of national ecological civilization and low-carbon transformation. Strengthening ideological and political education on energy conservation and emission reduction for college students will help China achieve the "dual carbon" emission reduction goals as soon as possible. Based on this, integrating the concept of low-carbon education into the construction of ideological and political education system in universities can help Shenzhen better achieve the "dual carbon" goals, can provide characteristic models and references for universities in other regions of the country to assist in energy conservation and emission reduction. Therefore, this article collects research data on low-carbon development and low-carbon campus construction from college students in Shenzhen, analyzes the cognitive level of campus education under the dual talk goal, explores the implementation path and measures of campus ideological and political education under the "dual carbon" goal, and provides theoretical support and practical reference for China to achieve low-carbon development and carbon neutrality goals.

2. Literature Review

Low carbon campuses and low-carbon education have been hot topics of concern both domestically and internationally in recent years. In order to address climate change and reduce greenhouse gas emissions, many countries and regions are actively promoting low-carbon development and low-carbon education. Table 2 shows the research progress and trends on low-carbon campuses and low-carbon education in developed countries in Europe and America.

Table 2: Research progress on low-carbon campuses and low-carbon education in various countries

country	Related measures	Measures content
Germany	Campus carbon neutrality	There are already universities in Berlin that are working to explore carbon neutrality on campus. Among them, the goal of Berlin Technology Institute is working to achieve the "carbon neutrality" by 2030, while Humboldt University Berlin recently established a specialized agency on "sustainable campuses".
Britain	"Low carbon transformation plan"	The UK Low Carbon Transformation Plan points out that the core goal of UK economic development is to build the UK into a cleaner, greener, and more prosperous country. At the same time, the "UK Low Carbon Industry Strategy", "Renewable Energy Strategy" and "Low Carbon Transport Plan" are supported to guide enterprises and the public to live a low-carbon life.
United States	US Recovery and Reinvestment Act, Clean Energy Program, etc	The American College Climate Commitment Program (ACUPCC) was launched in 2006. Currently, nearly 700 colleges and university presidents have signed ACUPCC to develop their own carbon neutrality plans.
Japan	"Low carbon campus plan"	A low-carbon campus plan has been formulated, and measures have been taken to control the use of electricity by introducing an external energy company, building a new school building using energy-saving technologies, promoting the president's and school-wide energy-saving campaigns, and renovating air conditioners and other machinery and equipment based on the medium- and long-term maintenance plan.
Sweden	"Master's degree in Environmental Protection"	The International School of Industrial Environment and Economics at Lund University in Sweden has been developing a youth environment and sustainable development education program since 1999, which has been successfully implemented and expanded in dozens of countries around the world.
Denmark	"Sustainable schools"	Denmark has successfully mitigated climate change by reducing greenhouse gas emissions, expanding the use of renewable energy, and phasing out fossil fuels through the participation of the legislature, government, academic and research institutions, and the whole society.
China	"Low Carbon Campus Action Plan"	China has released the Blue Book of Zero-Carbon Campus, which aims to plan zero-carbon campuses from five aspects: planning and ecology, energy and resources, environment and health, operation and management, and education and promotion.

Data source: The data were compiled by the authors.

From Table 2, Europe is one of the most active regions in the world for low-carbon development. Many European countries have formulated detailed low-carbon campus and low-carbon education policies, such as Germany's "Campus Carbon Neutrality" and the UK's "Low Carbon Transformation Plan". In addition, many European countries have also carried out a series of low-carbon education and practical activities, such as Sweden's "Little Master in Environmental Protection" program and Denmark's "Sustainable School" project. The U.S. government attaches great importance to low-carbon

development and has successively introduced a series of policies and regulations, such as the American Recovery and Reinvestment Act and the Clean Energy Plan. In terms of low-carbon education, many states and school districts in the United States have formulated sustainable development education standards and integrated low-carbon knowledge into the curriculum. In addition, many schools and communities in the United States have also carried out low-carbon practical activities, such as the "Green Campus Program" and the "Low Carbon Living Challenge". The Japanese government has proposed a "low-carbon campus plan" and formulated a "green growth strategy". In terms of low-carbon education, Japan has incorporated low-carbon knowledge into the curriculum of middle and high schools, and encouraged schools to carry out environmental protection activities and ecotourism. Linda Smith: Australian scholar with a focus on low-carbon campuses and sustainable educational practices. She proposed a model called "Sustainable Schools" that focuses on curriculum integration, environmental stewardship, community engagement, and teacher professional development. Peter Hall is a British scholar who studies low-carbon cities and low-carbon campuses. He proposed an approach called "low-carbon campus design" that aims to reduce carbon emissions on campuses through building design, energy management, and behavior change. Susan Watson is an American scholar focused on low-carbon education and climate change education. She proposes an educational framework called "Climate Change Literacy" to help students understand the science, impacts, and solutions of climate change. China also attaches great importance to low-carbon development, and has issued a series of policies and regulations, such as the "Energy Conservation Law" and the "Renewable Energy Law". In terms of low-carbon education, China's Ministry of Education has issued the "Notice on Strengthening Environmental Protection Education in Primary and Secondary Schools" and other documents, requiring low-carbon knowledge to be integrated into the education and teaching process. Many schools and enterprises in China actively carry out low-carbon campuses and low-carbon education practice activities. For example, the High School Affiliated to Tsinghua University has launched a "low-carbon campus action plan" to improve the low-carbon awareness of teachers and students through energy conservation and emission reduction, green travel, and garbage classification. In addition, some companies have also joined the ranks of low-carbon education, such as Alibaba's "low-carbon logistics plan" and Tencent's "low-carbon office project". At present, Chinese scholars have carried out a lot of research in the field of low-carbon campus and low-carbon education, involving theoretical discussion, practical strategies, and effect evaluation. These research results provide theoretical support and practical reference for the development of low-carbon campuses and low-carbon education in China.

Overall, European and American countries started their low-carbon education and campus construction in universities earlier than China. As early as the end of the last century (1999), European and American countries began to introduce the concept of low-carbon education into campuses, and have achieved a series of achievements in building low-carbon campuses. For example, the construction of a low-carbon campus at the University of California, Berkeley states in its plan that the construction of a low-carbon campus should be viewed as a long-term plan rather than a short-term plan, which can be intervened through management to ultimately achieve zero CO₂ emissions on campus [6]. Similarly, the University of Tokyo has established a clear action framework to achieve emission reduction targets, while combining the concept of low-carbon campuses with social level emission reduction. Through building energy-saving technology, a long-term emission reduction mechanism has been established through school society linkage. Research on low-carbon education on campuses in China started relatively late compared to Western countries. For research on energy conservation and emission reduction, China mainly focuses on reducing emissions in provinces, cities, and regions [3, 4], various industries [5], enterprises [7], and household consumption [8]. However, research on micro level campuses is clearly insufficient. Among the few relevant studies, low-carbon education at the primary and secondary school level is generally more prevalent than at the university level. Although some work has been carried out at the university level [9,10], the overall participation rate is still not high, and there is a lack of long-term planning, professional technical support, and long-term guidance on ideological education. In addition, low-carbon education in China (including Shenzhen) is showing a situation of popularization in primary and secondary schools and a gap in universities, which hinders the establishment and development of long-term energy-saving and emission reduction mechanisms in domestic universities.

3. Empirical analysis

3.1 Data sources and collection

This article mainly focuses on the cognitive level of college students in Shenzhen regarding low-carbon development and low-carbon campus construction. A survey questionnaire was developed based

on relevant research and scales both domestically and internationally, and the questionnaire was refined and measured through expert interviews to form the final questionnaire. The questionnaire mainly focuses on three aspects: the personal concept and goals of low-carbon development among college students, the measures taken by the school in the construction of low-carbon campuses, and the construction of low-carbon campus education in the school.

The data collection period for the questionnaire is from October to November of 2023. Total 3100 questionnaires were distributed and 3048 were collected, detail sample statistics can refer to table 3.

Table 3: Sample Statistics

	Sample	Numbers for interviewees	proportion
Types of institution	Comprehensive colleges and universities	65	2.13%
	Vocational colleges	2981	97.8%
	Other categories	2	0.07%
Gender	Man	976	32.02%
	Woman	2072	67.98%
Major	Science and Engineering	903	29.63%
	Humanities	1511	49.57%
	Medical Science	357	11.71%
	Art	16	0.52%
	Others	261	8.56%

3.2 Analysis of the cognitive level

The survey on the cognitive level of low-carbon development and low-carbon campus education was carried out from three aspects: college students' cognition of low-carbon development, the school's measures in low-carbon campus construction, and the needs of college students in low-carbon campus development and campus construction.

According to the survey results of college students' cognition of low-carbon development in Table 4, 21.06% of the respondents have a good understanding of the concept of "low-carbon development", 47.05% of the respondents have a relatively good understanding of the concept of "low-carbon development", 28.41% of the respondents have a general understanding of the concept of "low-carbon development", and 3.48% of the respondents still have no understanding of the concept of "low-carbon development".

Table 4: Understanding Level of "low-carbon development" among college students

Understanding of low-carbon development	Number of people	proportion
Very familiar	642	21.06%
Relatively familiar commonly	1434	47.05%
Not very familiar	866	28.41%
Completely unaware	20	0.66%
total	3048	100%

Data source: Organized by research data

Low-carbon development is a development model that focuses on reducing greenhouse gas emissions and aims to achieve economic, social and environmental sustainability. Its importance in sustainable development and climate change response can be better understood. First of all, one of the purposes of low-carbon development is to improve energy efficiency. By adopting more advanced and energy-efficient technologies and equipment, we can reduce energy consumption and improve energy efficiency. This can not only reduce the dependence on limited energy resources and reduce energy costs, but also reduce environmental pollution and greenhouse gas emissions, which is conducive to achieving sustainable development. Reduce greenhouse gas emissions from production, consumption, and transportation through the promotion of clean energy, energy efficiency, and the adoption of carbon capture and storage technologies. This will help mitigate global climate change, reduce the risk of extreme weather events, and protect ecosystems and human living environment. Through the development of clean energy, energy conservation and environmental protection industries, green transportation, and other fields, we will create new economic growth points, promote the optimization and upgrading of industrial structure, and achieve a win-win situation for the economy and the environment. Finally, low-carbon development focuses on the protection and restoration of the ecological

environment, and advocates green, low-carbon, and circular production and lifestyle. By strengthening ecological protection, reducing pollution emissions, protecting biodiversity and other measures, we will improve the quality of the ecological environment and provide a livable environment for mankind. At the same time, protecting the ecological environment will also help improve the efficiency of resource utilization, reduce the risk of natural disasters, and ensure the survival and development of human beings. To this end, the purpose of low-carbon development of college students in this survey is mainly carried out from four aspects: improving energy efficiency, reducing greenhouse gas emissions, promoting economic development, and protecting the ecological environment. According to the survey results in Table 5, total 78.6% of college students believe that low-carbon development can achieve environmental protection and economic benefits at the same time, from different perspectives, 9.17% of the respondents believe that low-carbon development can improve energy efficiency, 6.34% of the respondents believe that low-carbon development can reduce the greenhouse gas effect, 4.64% of the respondents believe that low-carbon development can protect the ecological environment, and only 1.22% of the respondents believe that low-carbon development can promote economic development.

Table 5: Perceptions of College Students on the Main Objectives of Low Carbon Development

The purpose of low-carbon development	Numbers of people	Proportion
Improve energy utilization efficiency	279	9.17%
Reducing greenhouse gas emissions	193	6.34%
Promoting economic development	37	1.22%
Protecting the ecological environment	141	4.64%
All the above	2391	78.60%
Total	3042	100%

Data source: Organized by data

It is the responsibility of each of us to advocate a low-carbon lifestyle, participate in low-carbon technological innovation, and pay attention to and support low-carbon policies to achieve sustainable development, respond to climate change and protect the ecological environment. A low-carbon lifestyle refers to minimizing energy consumption and CO₂ emissions in daily activities. This includes conserving water, electricity, and paper, choosing public transport or walking, buying low-carbon products, reducing food waste, and advocating a green lifestyle. Advocating a low-carbon lifestyle can improve the awareness of energy conservation and environmental protection, cultivate good living habits, and reduce personal carbon emissions, while low-carbon technological innovation refers to the research and application of new technologies and methods to reduce energy consumption and carbon dioxide emissions. This includes the research and application of clean energy technologies such as solar, wind, and geothermal energy, the design and construction of green buildings, the development and promotion of new energy vehicle technology, and the exploration of carbon capture and storage technologies. Low-carbon policies are relevant regulations, measures and strategies issued by the government to address climate change, protect the ecological environment, and achieve sustainable development, including carbon emission trading, carbon tax, low-carbon city pilot and other policies. Paying attention to and supporting low-carbon policies, including understanding the low-carbon policies of national and local governments, participating in environmental protection organizations or low-carbon communities, reflecting low-carbon policy suggestions to government departments, and supporting international cooperation to address climate change, etc., can promote policy formulation and implementation and provide policy support for low-carbon development. According to Table 6, 15.85% of the respondents believe that a low-carbon lifestyle should be advocated, 2.76% of the respondents believe that individuals should participate in low-carbon technological innovation, another 2.76% believe that low-carbon policies should be paid attention to and supported, and 78.28% of the respondents believe that they should advocate a low-carbon lifestyle and participate in low-carbon technological innovation. Paying attention to and supporting low-carbon policies is the responsibility that individuals should assume in paying attention to low-carbon development, which shows that low-carbon development and low-carbon education have become an important way for college students to participate in low-carbon development.

Table 6: Individual Responsibilities in Low Carbon Development

Participation methods	Number of people	Proportion
Advocate for a low-carbon lifestyle	483	15.85%
Participate in low-carbon technological innovation	84	2.76%
Pay attention to and support low-carbon policies	84	2.76%
All of the above	2386	78.28%
other	11	0.36%

Data source: Organized by research data

At present, low-carbon education is an important part of ideological and political education in colleges and universities, as can be seen from Table 7, total 92.39% of the respondents believe that low-carbon education plays an important role in college education, and 56.07% of the respondents believe that low-carbon education is very important. According to Table 8, total 72.37% of the respondents believe that the coverage of ideological and political education in colleges and universities is very comprehensive or relatively comprehensive, and 27% of the respondents believe that the coverage of ideological and political education in colleges and universities is very comprehensive in low-carbon campus education. There are also 25.07% of the respondents who believe that the coverage of ideological and political education in colleges and universities is average.

Table 7: College students' perception of low-carbon education

The importance of low-carbon education	Number of people	Proportion
very important	1709	56.07%
More important	1107	36.32%
Generally important	208	6.82%
Not important	15	0.49%
Very unimportant	9	0.3%

Data source: Organized by research data

Table 8: Coverage of College Ideological and Political Education on Low Carbon Campus Education

Coverage level	Numbers of people	Proportion
Very comprehensive	823	27%
Relatively comprehensive	1383	45.37%
commonly	764	25.07%
Incomplete	59	1.94%
Very incomplete	19	0.62%

Data source: Organized by research data

In addition, from the perspective of the form of low-carbon campus education, 44.32% and 44.16% of the respondents respectively preferred to carry out low-carbon campus education through lectures and practical activities, although 8.46% of the respondents preferred to carry out low-carbon campus education through courses, but the proportion was relatively small, and the results are shown in Table 9.

Table 9: Forms of receiving low-carbon campus education

form	Number of people	Proportion
Lecture	1351	44.32%
Curriculum	258	8.46%
Practical activity	1346	44.16%
Other	93	3.05%

Data source: Organized by research data

From the perspective of low-carbon campus education, online learning and practical experience are effective ways to improve college students' understanding of low-carbon campus education. According to Table 10, 37.63% of the respondents believe that online learning should be adopted, and 48.85% of the respondents believe that practical experience is an important way to improve the low-carbon campus of college students. It can be seen, in the process of carrying out low-carbon campus education in the future, we should pay attention to the use of a variety of campus education models, so as to improve the cognitive level of college students on low-carbon education.

Table 10: Ways to improve understanding of low-carbon campus education

mode	Number of people	Proportion
Online learning	1147	37.63%
Offline learning	361	11.84%
Practical experience	1489	48.85%
Others	51	1.67%

Data source: Organized by research data

4. Conclusion and policy recommendations

Based on the collection of 3048 questionnaires, this paper found that 8.11% of college students have a good understanding or very good understanding of the concept of "dual carbon", and 78.44% believe

that low-carbon development can improve energy efficiency, reduce greenhouse gas emissions, promote economic development and protect the ecological environment at the same time, 78.28% 92.39% of the respondents believe that low-carbon education plays an important role in college education. Low-carbon campus education plays an important role in promoting low-carbon development and achieving the "dual carbon" goal, and the following policy suggestions are put forward:

First, optimize the energy structure of the campus and diversify low-carbon activities. Increase the share of clean energy in total energy consumption. By improving energy efficiency, reducing carbon emissions on campus, carrying out green transportation, encouraging the use of low-carbon and environmentally friendly means of transportation, such as public transportation, bicycles, electric vehicles, etc., and restricting high-emission vehicles from entering the campus. In addition, teachers and students should be raised through publicity and education to raise their awareness of low-carbon life and cultivate low-carbon living habits, such as saving water and electricity, and reducing the use of plastic products

Second, reform the curriculum and teaching materials to incorporate the concept of low-carbon development. Analyze how to integrate the concept of low-carbon development into the curriculum and textbook reform. In the process of curriculum design, new knowledge and new perspectives related to low-carbon, environmental protection and sustainable development are integrated to maintain the modernity of the teaching materials. Strengthen practical activities and encourage students to participate in low-carbon, environmental protection and sustainable development related practical activities. Carry out activities such as low-carbon lifestyle publicity, environmental protection knowledge lectures, and low-carbon technology competitions to improve students' low-carbon awareness. Encourage students to participate in environmental volunteer services, such as participating in public welfare activities such as garbage sorting, afforestation, environmental protection publicity, etc., so that students can experience the importance of low-carbon and environmental protection.

Third, improve the energy efficiency of the campus and reduce the carbon emissions of the campus. Through the energy management system, real-time monitoring and data analysis of energy use on campus are carried out to discover problems and potentials in energy use, strengthen the classified management of waste, improve the resource recovery rate, reduce the impact of waste on the environment, promote green products, encourage teachers and students to adopt environmentally friendly and low-carbon consumption methods, and reduce the overall carbon emissions of the campus. In addition, we have set up green campus evaluation standards to regularly evaluate the energy efficiency and environmental friendliness of the campus to promote continuous improvement of the campus.

Fourth, establish a mechanism for school-enterprise cooperation and community participation. Analyze how to promote school-enterprise cooperation and community participation to jointly promote the development of low-carbon campus education. From the perspective of school-enterprise cooperation, we should actively promote and jointly carry out research on low-carbon education, and promote the reform and innovation of education content and methods. In addition, it actively practices low-carbon education, organizes students, teachers and community residents to carry out community low-carbon activities, advocates low-carbon lifestyles and improves residents' environmental awareness through community publicity activities in terms of energy conservation and emission reduction, green travel and waste classification.

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References

- [1] Z. Mi, J. Meng, et al. *Pattern changes in determinants of Chinese admissions [J]. Environmental Research Letters*, 2017, 12 (7): 074003
- [2] IPCC *Climate Change 2014- IPCC Fifth Assessment Report 2014. UK*
- [3] D. Guan, J. Meng, et al. *Structural decline in China's CO₂ emissions through transitions in industry and energy systems [J]. Nature Geoscience*, 2018, 11 (8): 551-555
- [4] Q. Wang, M. Zhao, et al. *Decomposition and decoupling analysis of carbon emissions from economic growth: A comparative study of China and the United States [J]. Journal of Cleaner Production*, 2018,

197:178-184

[5] J. Jia, Z. Gong, et al. *Analysis of drivers and policy implications of carbon dioxide emissions of industrial energy consumption in an underdeveloped city: The case of Nanchang, China [J]. Journal of Cleaner Production, 2018, 183:843-857*

[6] Zhao Jing. *The Experience of International Low Carbon Campus Construction in Chinese Universities [J]. International Urban Planning, 2010, 25 (02): 106-110*

[7] Y. X. Zhang, Z.H. Wang, et al. *Determinants and implications of employee electricity saving hat: An empirical study in China [J]. Applied Energy, 2013, 112:1529-1535*

[8] X. Zhang, L. Luo, et al. *Household carbon emission research: an analytical review of measurement, influencing factors and ignition prospects [J]. Journal of Cleaner Production, 2015, 103:873-883*

[9] Li Jing. *Exploration on the Construction of Low Carbon Campus of Jilin University [J]. Chinese Environmental Management Series, 2011, (02): 17-19*

[10] Mao Xuedong. *Exploration of Low Carbon Campus Construction [J]. Energy Research and Management, 2010, (03): 10-12*