

Research on the Carbon Peak and Carbon Neutralization Model in Colleges and Universities: Taking China University of Geosciences (Beijing) as an Example

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Abstract: The “3060” goal demonstrates China’s responsibility in actively responding to global climate, enhances China’s voice and influence in climate governance, and sets an example of energy conservation and emission reduction for developing countries. As the main institutions that educate people for the Party and the country, colleges and universities have the responsibility to explore the realization path of carbon peak and carbon neutralization against the new problems encountered in the practice of energy conservation and emission reduction in colleges and universities. In response to the national strategy and the action plan of the Ministry of Education, taking the carbon practice of China University of Geosciences (Beijing) as the starting point, this paper conducts benchmarking research on the path of carbon peak and carbon neutralization in universities through the ecological factor method, campus carbon footprint, and questionnaire analysis.

Keywords: Carbon peak; Carbon neutralization; Colleges and universities; Conserve energy; Reduce emissions; Benchmarking research

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1. Introduction

In 2021, the Ministry of Education released the Action Plan for Carbon Neutral Scientific and Technological Innovation in Colleges and Universities, which points out the direction for energy conservation and emission reduction goals in colleges and universities. Colleges and universities must assume the leadership role in the community of shared future for mankind and shoulder the responsibility of providing scientific and technological innovation for economic and social transformation. Colleges and universities should seize the opportunity, fulfill the mission and the “3060” goal, as well as explore the origin of carbon peak and carbon neutralization in colleges and universities.

2. Background of “3060”

“Carbon peak” refers to the highest point at which carbon dioxide emissions of a region or an industry cease from increasing and begin to decline at a certain time period, that is, the historical turning point at which carbon dioxide levels start to drop. “Carbon neutralization,” on the other hand, refers to the process whereby the organization as a whole achieves a balance between the emission and absorption of carbon dioxide within a certain period of time. Carbon peak and carbon neutralization are important goals and directions

to prevent greenhouse gases from affecting the climate. The implementation of the “14th Five Year Plan” and the comprehensive promotion of the low-carbon transformation of the national economy are major strategic measures.

In the long history of human evolution, the climate situation and climate change, the changes in the living environment caused by both of them, and the innovation and widespread adoption of production technology are important driving forces that promote the development of human society and the evolution of civilization. On September 22, 2020, Chian solemnly announced at the 75th session of the United Nations General Assembly that China will increase its national independent contribution, adopt more powerful policies and measures, strive to reach carbon peak by 2030, and strive to achieve carbon neutrality by 2060^[1]. At the 29th Learning Conference of the Political Bureau of the Central Committee of the Chinese Communist Party, the importance of carbon peak and carbon neutralization was repeatedly emphasized^[2]. At the meeting of the Political Bureau of the Central Committee of the Chinese Communist Party in July 2021, the action plan for carbon peak by 2030 was recommended to be introduced as soon as possible^[3]. Three documents were issued within one week in October 2021: “Opinions of the Central Committee of the Communist Party of China and the State Council on the Complete, Accurate, and Comprehensive Implementation of the New Development Concept to Achieve Carbon Peak and Carbon Neutralization^[4],” “Notice of the State Council on Printing and Distributing the Carbon Peak Action Plan by 2030^[5],” and “Opinions of the General Office of the Central Committee of the Communist Party of China and the General Office of the State Council on Promoting Green Development of Urban and Rural Construction^[6].” At the end of December 2021, the State Council issued a notice on the issuance of the 14th Five Year Comprehensive Work Plan for Energy Conservation and Emission Reduction^[7].

Under the background of “3060,” the “14th Five Year Plan” period is the key period to achieve carbon peak. As a key unit of energy consumption, the scale of energy use, management level, lifestyle, and consumption concept of colleges and universities determine the characteristics of carbon emissions. The per capita energy consumption is far higher than the urban average. Urban carbon emissions account for more than 85% of the country’s^[8], and energy-related carbon dioxide emissions are approximately 10 billion tons^[9]. However, since 2012, more than 800 universities in more than 100 countries have joined the “Global Environment and Sustainable Development University Alliance,” but none of them has officially conducted scientific measurement and target management of carbon emissions. If the innovation of production technology makes new buildings green, the annual consumption of 3,005 colleges and universities across the country will be reduced by 15%–30%^[11]. If colleges and universities have a unified plan for carbon emissions and further disseminate technological innovation, the economic and social benefits of carbon neutralization in colleges and universities will be more evident.

After the goal of “3060” was put forward, Chinese universities began taking their own measures one after another. Tsinghua University established the “World University Climate Change Alliance”; Peking University and Sichuan University established the “Carbon Neutralization Research Institute”; Tongji University held a forum titled “Dual Carbon Goals and Paths for Colleges and Universities” and is conducting a comprehensive study on dual carbon strategy; Zhejiang University, University of Science and Technology of China, Shanghai Jiaotong University, Zhejiang University, Nanjing University, East China Normal University, Southeast University, and Fudan University jointly signed the “Declaration on Carbon Neutralization Action in Chinese Colleges and Universities”, established the “Yangtze River Delta University Alliance for Sustainable Development,” signed the Charter of Yangtze River Delta University Alliance for Sustainable Development, and issued the “Initiative for Promoting Double Carbon Action in Colleges and Universities”; China University of Geosciences (Wuhan) initiated the preparation for the “Carbon Neutral Plan”^[10]; China University of Geosciences (Beijing) officially launched the construction of a green campus in 2022. Efforts are made in teaching, scientific research, field practice, logistics support,

and other aspects to implement the critical task of energy conservation and emission reduction.

This paper takes the practice of carbon peak and carbon neutralization in China University of Geosciences (Beijing) as an example to analyze the problems and corresponding solutions in hope to provide reference to universities for carbon emission reduction.

3. Carbon peak and carbon neutralization practice

As of August 2022, China University of Geosciences (Beijing) has 1,461 faculties and 16,898 students, covering an area of 453,300 square meters and a building area of about 523,000 square meters, with 29 energy-consuming buildings, including 13 teaching buildings, 9 dormitory buildings, 2 office buildings, 1 library, 1 gymnasium, 1 conference center, 1 school infirmary, 2 canteens, 1 waste station, 1 express station, 10 power distribution rooms, 1 boiler room, and other supporting facilities. The energy consumption system includes heating, catering, power transformation and distribution, central air conditioning, elevators, experimental instruments, office equipment, solar energy, lighting, water supply, garbage stations, road traffic, *etc.*

Based on the top-level design of the “3060” goal, the “14th Five Year Plan,” and the requirements of Beijing, all colleges and universities are actively implementing carbon emission-related measures, so that the long-awaited emission reduction projects can be implemented one after another. However, almost half of the projects, with one ton of carbon sink calculated at 40 yuan, did not meet the expectations, that is, the input and output were not positively correlated. Additionally, the income of some projects was calculated on a 3-year cumulative basis, yet the income was still lower than the cost; thus, none of the problems were in fact solved. The reasons are discussed in detail as shown in **Table 1**.

Table 1. Energy saving projects implemented by China University of Geosciences (Beijing) from 2019 to 2022 and their emission reduction effects

Year	Emission reduction projects (40 yuan for one ton of carbon sink)	Carbon dioxide emission reduction calculated at 40 yuan per ton of carbon sink, tCO _{2e}	Economic performance (10,000 yuan)	Met the expectations
2019	Protect green and add green	369	14.76	No
	Reconstruction of water pump and motor in boiler room and heat exchange station	1,264	50.56	Yes
	Smart classroom	1,037	41.48	No
	Energy saving platform	1,382	55.28	No
2020	Installation of solar water heater	3,756	150.24	Yes
	Reform of heating operation system in teaching area	412	16.48	Yes
	Eliminate high energy consuming equipment	653	26.12	Yes
	Reconstruction of intelligent electricity meter in student dormitory	487	19.48	Yes
2021	Water pipe upgrading	1,101	44.04	No
	Installation of LED lights in office building and teaching buildings	1,248	98.9	No
	Installation of charging pile	621	24.84	Yes
	Refuse classification	785	31.40	No
	Centralized accommodation during holidays	337	13.48	Yes

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Year	Emission reduction projects (40 yuan for one ton of carbon sink)	Carbon dioxide emission reduction calculated at 40 yuan per ton of carbon sink, tCO ₂ e	Economic performance (10,000 yuan)	Met the expectations
2022	Teaching 1, teaching 2, teaching 3 transformation and upgrading	Not counted in less than a year		No
	Upgrading the energy conservation supervision platform	214	8.56	No
	Expanding the green area, and changing the types of green plants	158	6.32	No

Abbreviations: LED, light emitting diode; tCO₂e, tons (t) of carbon dioxide (CO₂) equivalent (e).

As shown in **Table 1**, during the four years (2019–2022), in addition to completing a series of energy-saving transformation projects, China University of Geosciences (Beijing) passed the evaluation and gained the approval of energy-efficiency leaders of public institutions and water-saving universities; completed the energy consumption statistics, carbon emission verification and compliance, as well as energy utilization report; upgraded the software system of the energy-saving supervision platform and updated the platform user interface to a more intuitive and easy-to-use web configuration software; entrusted the hydropower center to model and arrange a special network – the energy-saving supervision platform; grasped the distribution and trend of the special network points and drew the topology map of the special network; and achieved the energy conservation goals of Haidian District in 2020 and the 13th Five Year Plan. China University of Geosciences (Beijing) passed the comprehensive supervision of Beijing Energy Conservation Supervision Brigade on energy conservation of key energy consuming units in 2021; the verification and allocation of water use indicators are completed by the Beijing Water Conservation Management Center; “double carbon” publicity and education are carried out around the establishment of green schools. At nodes such as Water Saving Publicity Week, Energy Saving Publicity Week, and Patriotic Health Campaign Month, many promotional articles on water saving, energy saving, and carbon emission reduction are published on the official account; the green house community is instructed to create a water-saving propaganda, “Water Pollution in Environmental Protection Classroom,” the science on water pollution and the current situation of water pollution in China are popularized, and students are encouraged to love, cherish, and save water. In April 2022, the campus management center took the lead in carrying out the “double carbon” thematic activity of “Patriotic Health Campaign Month, Build A Beautiful Campus Together” with relevant departments and guided students in low-carbon and energy conservation with the campus carbon footprint as the main line.

4. Problem analysis

The carbon emission reduction practice of China University of Geosciences (Beijing) basically represents the average of Beijing universities. In recent years, in the process of transformation, implementation, and technological application of energy-saving projects, carbon emission reduction has achieved some results, but nearly half of the projects did not meet the expectations. The main reasons are further discussed below.

The energy consumption department has not clarified the formal, standardized, and open carbon emission inventory of the campus. Without a carbon emission inventory, it is impossible to gauge the current situation of carbon emissions, understand the potential, path, and methods of emission reduction, or scientifically and systematically formulate carbon emission indicators and accounting guidelines for carbon emissions in colleges and universities.

The energy consumption management department has not formulated any “double carbon” schedule with regard to the carbon emission and financial reality of the university. A schedule for direct carbon emissions, indirect emissions, and carbon offsets for catering centers, hot water supply, electricity operation, energy-saving platforms, academic exchanges, and travel has not been determined, thus affecting the design and implementation of carbon emission reduction strategies. Beijing University of Science and Technology should be referred to for the formulation method and implementation schedule.

The completed energy conservation projects did not meet the expectations. For example, the upgrading of the three teaching buildings, the installation of solar water heaters in student dormitories, the replacement of environmental sanitation vehicles with new energy vehicles, the replacement of lighting with LED energy-saving lamps, and the classification of waste. In order to save money, the school did not strictly comply with the campus carbon emission reduction requirements that were issued by the Ministry of Education, the Ministry of Housing and Urban Rural Development, and other relevant functional departments, in combination with the situation of the school, to achieve the expected goals. Therefore, it is necessary to broaden the fund channels and alleviate the financial pressure of colleges and universities through climate investment and financing as well as the social capital model of multi-party combination, including the government, enterprises, and universities.

There is also a dearth of professionals to achieve the “double carbon” goal. At present, China University of Geosciences (Beijing) has not introduced any courses related to “carbon neutralization” and “carbon peak.” In addition, it has no relevant cross-disciplinary and professional construction, let alone “double carbon” majors and disciplines of double first-class. Due to the lack of professionals, the implementation of campus carbon emission reduction projects and the publicity and education of “double carbon” have not met the expectations. Furthermore, the carbon neutral cultural atmosphere, including personal carbon footprint, carbon credits, and carbon inclusion, has not yet taken shape. Compared with universities in developed countries, for example, Hull University in the United Kingdom, which regards campus as a “living laboratory” for energy technology innovation, one of the three key tasks of carbon neutralization^[11], Chinese universities still have a long way to go in terms of “double carbon” production, learning, and research construction.

The “double carbon” heart in campus has not been formed. The Ministry of Science and Technology has taken the lead in preparing the List of Technologies to Combat Climate Change, which is a list of existing technology promotion^[12]. The list focuses on the transformation and upgrading of traditional technologies, the production and application of renewable energy, technical and economic management decisions, *etc.* This is the research scope of the center. In addition, the management function of the center should involve the optimization of the “double carbon” system, implementation plan, schedule, road map, and long-term planning for the sustainable development of the school. The director of the center must be the leader of the school and make overall plans for carbon neutralization of the whole system, including teaching, scientific research, government procurement, building transformation, new energy application, *etc.*^[5].

To sum up, colleges and universities should begin from reality, face the “double carbon” problem, optimize and integrate the energy management of the school with the “14th Five Year Plan” as well as the discipline development plan with the “3060” goal, make scientific deployment, ensure the development of energy use, practice the national energy conservation policies, and increase the application and promotion of mature energy-saving products and technologies. All colleges and universities should consider the situation, innovate energy management means, further promote household measurement projects, improve the coverage and expand the measurement depth of the energy supervision platform, dig deep for energy conservation and emission reduction, strengthen the school’s income and saving measures, improve the input-output ratio of school energy, and effectively reduce the school’s public energy expenditure. All

colleges and universities should encourage the participation of both teachers and students through system implementation, publicity, and guidance; form a joint force within the school; improve the school's management efficiency; and strengthen the capabilities of professional and technical personnel.

5. Method exploration

Based on the potential analysis of carbon emission reduction projects and the current problems, compared with the “3060” goal, the emission reduction path of universities can be analyzed.

5.1. Set a “double carbon” center

In order to focus our scattered conscious actions on major issues and complete the “double carbon” goal on schedule, colleges and universities need to set up “double carbon” centers that are led by the leaders of major universities. Only the leaders of key universities have the courage to focus on the strengths of various disciplines to carry out the inventory, management, and research of campus carbon emissions, combine the university's resource endowment and development characteristics, identify weaknesses, solve the bottleneck problem of low-carbon development, and introduce a “carbon neutral” plan, a “carbon neutral” preparation standard, a “carbon neutral” path guidance, a “carbon neutral” offset scheme design, a “carbon neutral” evaluation standard and assessment method, “carbon neutral” professional talent training, and a “carbon neutral” management and financial system, integrate the “carbon neutral” concept into school construction, as well as establish a “double carbon” special fund for carbon offset and related scientific research, teaching, and energy-saving project transformation, so as to create a diversified, promotable, and grounded “green model.”

5.2. Energy-saving project transformation and collaboration

Energy conservation projects are the main body to implement the long-term emission reduction task of colleges and universities. To achieve the “dual carbon” goal, it is necessary to identify the key emission drivers, quantitatively evaluate the long-term emission reduction capacity ^[13], carry out bottom-up exploration and innovation project research, as well as achieve the same goal through different routes in combination with the phased characteristics of colleges and universities' own emission reduction.

5.3. Application of green technology

The science and technology support for green technology application is China's key to achieving carbon peak goal and carbon neutrality vision and participating in global climate governance ^[19]. The “double carbon” path applied to colleges and universities is mainly reflected in three aspects: buildings with low carbon design technology, new energy promotion technology, and application technology innovation.

5.4. Construction of an innovation platform and transformation of scientific and technological achievements

Encourage universities to build a scientific and technological innovation platform with the theme of “double carbon,” a “double carbon” research center, an industrial technology innovation center or a “double carbon” teaching laboratory with the cooperation of universities, governments, enterprises, communities, disciplines, teachers, and students, so as to draw on professional advantages, solve the problem of carbon summit, promote scientific and technological innovation in the double carbon field, as well as promote the industrialization of science and technology, so as to guide the direction of development in terms of the efficient utilization of economic and social resources and green low-carbon.

5.5. “Double carbon” education diversification

The low carbon concept is not widely recognized by both teachers and students. Their zero-carbon knowledge is lacking, and their subjective awareness of “carbon neutrality” is weak. It would be difficult for a subjective low carbon cognition to play an active role in the “double carbon” goal of colleges and universities. However, there is no mature policy that can be practiced for differentiated guidance. Therefore, “dual carbon” education should be integrated into the curriculum system of various disciplines, and “dual carbon” general education courses and national quality courses should be established. Promoting the construction of “double carbon” cross-disciplines and specialties and striving to create double first-class specialties and first-class disciplines would also be beneficial. Through a series of incentive mechanisms such as carbon inclusion, carbon integral, and carbon credit, a variety of “dual carbon” publicity activities should be carried out, while creating a campus environment that embodies “dual carbon” culture and promoting carbon neutrality in large-scale events, conferences, waste classification, *etc.*

6. Conclusion

Driven by the global “3060” goal, all colleges and universities are now promoting low-carbon and zero-carbon emission reduction efforts on campus according to their own situation. However, due to the lack of involvement of university management and the coordination of various supports from both within and outside universities, the “dual-carbon” model is still being explored. China University of Geosciences (Beijing) has taken the lead in exploring this model and the continuous optimization of the scheme, hoping to help identify major emission sources and ensure that the campus carbon accounting and inventory work of greenhouse gas emissions is carried out well. According to the data provided by carbon accounting, it would be helpful to implement carbon monitoring work on major emission sources, apply technical means to optimize carbon emission design and transformation scheme, as well as optimize the roles of campus green space vegetation carbon sink and forest carbon sink.

Disclosure statement

The author declares no conflict of interest.

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