
Research on Green Campus Construction Based on College Students' Carbon Footprint under Low Carbon Economy

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Abstract: Green campus construction is an innovative concept under the constraint of ecological environment capacity and resource carrying capacity. As a new force to promote the development of low-carbon economy, college students' understanding and practice of green development concept will have a far-reaching impact on the sustainable development of ecological environment. This study takes the carbon footprint of college students in 30 universities in Beijing from four aspects of clothing, food, housing and use as the entry point, takes the ecological balance theory as the basis, and uses questionnaire survey and interview as the research method to calculate the campus carbon footprint of college students, analyzes the current situation of campus carbon footprint, and discusses the practical path of energy conservation, carbon reduction and green campus construction.

Keywords: Low-carbon economy; Colleges and universities; College students; Carbon footprint; Green campus; Practice path

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1. The Background of Green Development Concept under Low-carbon Economy

Since the industrial Revolution, the rapid development of the world economy has attracted much attention to the environmental problems that lead to global warming. The practice of low-carbon economy has resulted in the emergence of carbon footprint. College students' emotional willingness to environmental protection, their awareness of green concepts and environmental protection behaviors in daily life are related to the overall development of their own quality and determine the economic development of beautiful China. Therefore, it is imperative to cultivate college students' concept of green development. Through the review of the existing literature, it is found that scholars have abundant researches on the concept of green development, but there are few researches on the green campus construction based on the carbon footprint of college students. This research direction needs to be further explored and practiced.

A carbon footprint is the amount of carbon consumed by a person or group. Carbon, is oil, coal, wood and other natural resources composed of carbon elements. The more carbon is consumed, the more carbon dioxide is produced

and the larger the carbon footprint. Common methods for calculating carbon footprint include: life cycle method, IPCC carbon footprint calculation, input-output method, and Kaya carbon emission identity. Application scope of life cycle method: the whole process of products from raw materials being mined to waste treatment. Advantages: carbon emission assessment based on life cycle is more comprehensive and whole-process, which is conducive to improving accuracy. Disadvantages: Easy to be affected by subjectivity, the calculation of carbon emissions may be repeated, the classification standard of each stage is not clear, and more data are required, which is not easy to collect. Application of IPCC carbon footprint calculation: agriculture, industry, waste treatment, etc. Advantages: After determining the right model, the calculation of carbon footprint will save a lot of labor and time. Disadvantages: According to the input-output calculation, the result has a certain deviation. Application scope of input-output method: carbon footprint of the study area, residential and other levels. Advantages: The direct and indirect effects of economy on carbon emissions can be analyzed. Disadvantages: There will be bias in the calculation process, which only applies to the assessment of the carbon

footprint of a certain department or enterprise, but not to a certain product. Kaya carbon emission identity is an exponential decomposition method, which can drive the decomposition of total carbon emissions. It is a relatively mainstream analysis method, which is suitable for the investigation of carbon emission factors.

The purpose of this study is to understand students' behavior habits of clothing, food, housing and use, and calculate carbon dioxide emissions according to the carbon footprint assessment of daily necessities and consumption. On a weekly basis, carbon emissions from the quantity of clothes purchased, washing, and water and electricity used in ironing, etc., and carbon emissions from the consumption of household goods. On a daily basis, carbon emissions from the amount of food and the use of tableware and consumables, and carbon emissions from the use of water and electricity in accommodation, etc. Most commonly used carbon dioxide emissions = item consumption * unit emission factor. The emission factors mainly used are shown in Table 1.

Table 1. Emission factors.

Category	Carbon emission factor	Source
Water	0.19 kgco ₂ e/t	National Development and Reform Commission (2015)
Electricity	0.19 kgco ₂ e/kw*t	National Development and Reform Commission (2015)
Laundry detergent	0.72 kgco ₂ e/kg	Treehugger
Rice	2.7kgco ₂ e/kg	Treehugger
Meat	12.1 kgco ₂ e/kg	Treehugger
Cooked wheaten food	3.57 kgco ₂ e/kg	Ministry of Environment of Japan (2018)
Egg	4.8 kgco ₂ e/kg	Treehugger
Milk	1.9 kgco ₂ e/kg	Treehugger
Apple	0.026 kgco ₂ e/kg	UK Centre for Energy Research (2018)
Plastic bag	0.1 kgco ₂ e/kg	UK Centre for Energy Research (2018)

2. The Carbon Footprint of Clothing, Food and Housing

The questionnaire was designed according to the research questions to understand the status quo of college students' carbon footprint behavior in Beijing area, and to obtain relevant data and carbon footprint factors. Random sampling was adopted in this survey. The sampling situation of 11 universities was shown in Table 2. 5282 questionnaires were sent out, 5200 were recovered, with

a recovery rate of 98.45%, 22 invalid questionnaires were removed, 5178 were valid, and 98.03% were effective.

Table 2. Sampling situation table.

Colleges and universities	Number of people	Sample size (2%)
Tsinghua University	36305	726
Renmin University of China	28501	570
Beijing University of Aeronautics and Astronautics	22856	456
Beijing Institute of Technology	30733	614
Minzu University of China	27295	544
China University of Petroleum (Beijing)	22769	454
China University of Geosciences (Beijing)	16898	336
University of Science and Technology Beijing	22569	450
North China Electric Power University	12334	246
Beijing Forestry University	25347	506
Beijing Jiaotong University	19061	380

According to the analysis of valid data in Table 3, the proportion of female students is 68.13% and that of male students is 31.87%. The participation rate of female students is more than twice that of male students. Undergraduate students account for 66.82%, master's students 31.38% and doctoral students 1.72%. The participation of undergraduates is more than twice that of postgraduates. The cost of living below 1500 yuan accounted for 30.65%, between 1500 and 2500 accounted for 32.27%, between 2500 and 3500 accounted for 20.43%, over 3500 accounted for 16.65%, the high and low cost of living affects the consumption behavior of students, determines the consumption status of students.

Table 3. Questionnaire information table.

Student category	Number of people	Percentage%
Boy	1650	31.87
Girl	3528	68.13
Undergraduate	3460	66.82
Master student	1625	31.38
Doctoral student	89	1.72
Other	4	0.07
Living expenses below 1500	1587	30.65
Living expenses: 1500-2500	1671	32.27
Living expenses: 2500-3500	1058	20.43
Living expenses above 3500	862	16.65
Total	5178	100

In order to ensure the authenticity and objectivity of the data, the interviews were mainly conducted with resident

students from different departments, majors and grades. The interview data are an effective supplement to the questionnaire data. See Table 4. In the interview, it is found that people's understanding of carbon footprint is divided into three situations. First, totally unheard of; Secondly, I have some understanding of low-carbon, but it is limited to traditional coal and exhaust emissions, and the concept of low-carbon cannot be connected with daily life. Thirdly, I have a detailed understanding of the carbon footprint and the carbon dioxide produced in my daily life.

Through the collation and analysis of questionnaire and interview data, the carbon footprint of 5178 college students in Beijing was assessed.

2.1 Clothing Carbon Footprint

As shown in Table 5, according to the calculation of the carbon footprint of clothing, the carbon footprint in recognition is 19,269.10 kgco₂e. Buying clothes has the highest carbon footprint, followed by washing clothes by machine, and washing clothes by hand has the least carbon footprint.

2.2 Eating Carbon Footprint

As shown in Table 6, according to the eating habits of students, the carbon emissions of three meals a day are calculated, and the carbon footprint of food is 23001.91 kgco₂e. Meals have the highest carbon footprint, followed by take-out, beverage, disposable chopsticks and disposable lunch boxes in the order of carbon emissions.

2.3 Residential Carbon Footprint

As shown in Table 7, students' residential carbon footprint mainly consists of domestic water, electricity and equipment. The daily residential carbon footprint is 8601.49 kgco₂e. Domestic water has the highest carbon footprint, followed by turning on lights, computers, hair dryers, mobile phones and bathwater in order of carbon emissions.

2.4 Behavioral Carbon Footprint

As shown in Table 8, the carbon footprint in use is calculated, mainly including scratch paper, roll paper, extraction paper, printer paper and plastic bag. The daily carbon footprint in use is 377.52. Paper products have the highest carbon footprint, followed by plastic bags.

Table 4. Interview content.

Dimension	Content
Cognition	Carbon footprint understanding The significance and function of green campus Low carbon measures and weaknesses
Attitude	Whether to support low carbon and environmental protection How to choose the low-carbon way The impact of low carbon campus on you
Suggestion	Low carbon problems and reasons What are the carbon footprint reductions How to achieve peak carbon and carbon neutrality

Table 5. Clothing carbon footprint.

Option	Amount	Carbon emission factor / kgco ₂ e	Power consumption / kwt	Electric emission factor / kgco ₂ e/kw.h	Water consumption /L	Water discharge factor / kgco ₂ e/t	Total carbon footprint / kgco ₂ e
Weekly clothing shop	4621 piece	4					18484
Machine wash clothes every week	5570 frequency		534.72	0.61	751950	0.19	469.1
Wash clothes by hand every week	124 frequency	0.19			123710		23.5
Use laundry detergent every week	406.3 kg	0.72					292.5
Clothing carbon footprint total	19269.1						

Table 6. Food Carbon Footprint (three meals a day).

Category	Amount (kg)	Carbon emission factor / (kgco ₂ e/kg/t)	Total / (kgco ₂ e)
rice	687.25	2.70	1855.60
meat	1106.00	12.10	13382.60
pasta	486.00	3.57	1735.00
vegetable	1494.00	0.59	881.50
egg	188.00	4.80	902.40
milk	538.2	1.90	1022.60
apple	676.00	0.026	17.60
banana	436.50	0.98	427.80
Dragon fruit	334.00	0.30	100.20
peach	241.5	0.96	231.8
grape	1.65	0.48	0.8
drink	102.57 L	0.319 kgco ₂ e/ 1.5L	21.81
take-out	1090	2.0286 kgco ₂ e	2211.20
Disposable chopsticks	6990	23 kgco ₂ e/thousand	160.8
Disposable lunch box	5690	2.90 kgco ₂ e/kg	49.5
Plastic bag	6580	0.1 kgco ₂ e/thousand	0.70
Total food carbon footprint	23001.91		

Table 7. Carbon footprint.

Category	Water consumption /L Electricity consumption /kw.h	Carbon emission factor / kgco ₂ e/t	Total carbon footprint / kgco ₂ e
Hot water	25712.00	0.19	4.9
Domestic water	33648.08	0.19	6393.10
Bathing water	161993.00	0.19	30.79
Turn on the lights in the dormitory	1187.00	0.61	724.10
Mobile phone power consumption	142.95	0.61	87.2
Computer power consumption	1186.00	0.61	723.50
Electric hair dryer	1045.80	0.61	637.90
Total carbon footprint	8601.49		

Table 8. Row carbon footprint.

Category	Quantity/ per piece	Carbon emission factor / kgco ₂ e/t	Total carbon footprint /kgco ₂ e
Paper products	106.29	3.5 kgco ₂ e/t	372.02
Plastic bag	5501	0.1 kgco ₂ e/thousand	5.5
Add up the carbon footprint	377.52		

3. Economic Analysis of Carbon Footprint

Carbon footprint analysis plays an important role in the development of individual behavior habits and environ-

mental awareness, and is of great significance to the construction of green campus under the low-carbon economy.

According to the questionnaire survey and interview,

76.48% of students prefer cotton clothing and 42.38% choose polyester fabric. In terms of washing methods, 23.61% of students choose hand washing, 19.64% are used to machine washing, 43.21% choose a combination of hand washing and machine washing. Relevant studies have shown that when shopping, consider that natural fibers are lower carbon than chemical fibers, and wool and cotton are lower carbon than nylon, acrylic and polyester^[1]. Among the disposal methods of waste clothing, landfill, incineration and secondary utilization, secondary utilization is low carbon^[2]. When students dispose of clothes, 36.17 choose to keep them, 26.57% choose to throw them directly into the trash, and 18.32% choose to give them to others.

In terms of food, 56.42% of students never waste, 36.54% of students waste once, and 10.27% of students waste twice and three times. Those who did not pack accounted for 23.15%, those who often packed accounted for 28.36%, and those who often packed accounted for 56.37%.

In terms of living, 59.32% of those who can turn off the lights, 16.31% of those who occasionally turn off the lights, and 10.38% of those who never turn off the lights.

In terms of usage, daily necessities, clothing and food account for 50.21%, 24.35% and 27.69% respectively.

In terms of express processing, 68.65% of students use express packaging. 37.92% of the students thought that express package was convenient and fast, and they were not aware of the environmental problems caused by packaging. 21.32% of the students were aware of the garbage and environmental pollution caused by packaging. 17.68% of the students thought express package was a waste of resources and not environmentally friendly. Therefore, 61.78% of students choose to discard directly, 27.35% put into recycling bins and 7.27% use wastes.

From the above confirmatory analysis of carbon footprint data on the personal cognition, emotional intention and practical behavior of college students in Beijing, all show significant positive effects, indicating that college students have a good understanding and practice of the concept of green development. Students can realize the long-term significance of low-carbon life, have a certain awareness of low-carbon behavior, but also can find some problems. In the process of building a green campus, students should fully understand students' learning needs and life needs, such as electricity, dining, shopping, etc., respect students' freedom of choice in the low-carbon guidance, formulate relevant low-carbon measures on the premise of people-oriented, and guide students' ideology

and behavior habits.

4. Economic Measures to Reduce Campus Carbon Footprint

4.1 Promote the Self Cognition of Student Groups, and Help Them to Constantly Deepen Their Understanding of the Concept of Green Economy Development in the Learning of Relevant Theoretical Knowledge

The research of domestic scholars on the cultivation path of the concept of green development mainly has the following views: Zhang Wei and Xue Juan believe that the concept of green development is specifically incorporated into the operating system and mechanism of colleges and universities, which is to implement green education by building a green school system^[3]. Bi Xueyan and Zhu Weili, aiming at building the concept of green development in some regions, take ideological and political education as the basic perspective, fully use the relevant concepts of environmental science and economics, and combine ecological civilization education with ideological and political courses in colleges and universities. Based on the analysis of specific environmental problems, the paper puts forward countermeasures and suggestions for the cultivation of green development concept^[4]. Yang Fangshuo and Bi Lei mainly thought about the shortcomings in the management of ideological and political education in colleges and universities, and discussed how to effectively improve the ideological education effectiveness of students with the concept of green development of Yuxian County^[5]. Shan Wenfeng pointed out that under the background of the concept of green development, ideological and political education in colleges and universities needs to adopt various ways such as theoretical teaching, practical guidance and environmental influence to cultivate students' green value orientation, green career choice and green lifestyle^[6].

4.2 We Should Tap the Cultivation Function of the School, Constantly Optimize the Education System, Enrich the Campus Environment and Related Facilities, and Create a Campus Activity Culture of Green Economy

Setting up a scientific and reasonable education system mainly involves three aspects. Improve the education level of teachers and open green education classes; Increase the investment in green development education; Enrich teaching forms and methods.

Open green campus activities. By holding lectures on the concept of green development, students can turn the content and values of green ideas into their own code of

conduct. Schools, communities and streets should jointly create a green lifestyle atmosphere to cultivate students' self-education ability and green habits. In combination with radio, television, newspapers and other media, promote the country's concept of green development, guide students to pay attention to waste pollution, air pollution, water pollution, noise pollution, etc., and be moral, idealistic, responsible, responsible, daring to think, daring to say, daring to be creative in the new era.

4.3 Build a Harmonious Campus Environment, Create an Educational Atmosphere of Green Economy, and Cultivate a Healthy Concept of Life and Consumption

Ecological concept education in traditional culture. For example, Confucianism lists the idea of the unity of man and nature as its goal, and realizes the importance of harmonious coexistence between nature and human beings. Taoism also has its own unique views, pointing out that in the process of ecological development, we should look to naturalism, and respect everything and nature as the highest criterion of social behavior. These historical and cultural heritages have provided reference for the green development concept that we advocate now. Green consumption education is a healthy and positive consumption concept that students should focus on avoiding damage to the environment and optimizing the environment when consuming.

4.4 Cultivate the Economic Awareness of Protecting the Ecological Environment, Formulate Relevant Laws and Policies, and Guide All Teachers and Students to Actively Respond to the Call of the Green Development Concept

Resources and environment education is an important part of green economy education in colleges and universities. Lack of understanding of this education will lead to students' insufficient understanding of ecological crisis and attention. The implementation of this education can vigorously cultivate students' awareness of ecological crisis, environmental protection responsibility, ecological balance awareness, low-carbon economic development, etc., enable students to understand the importance and urgency of environmental protection and green development, and help students establish the values of caring for the environment and fearing nature.

Formulate relevant regulations, policies and systems. For example, flexibly adjust the heating and cooling time and intensity, and install solar energy systems in all buildings. The fixed time light off control system and infrared detection device are installed in the whole school, and the light off time is controlled uniformly according to the

measurement, and the voice control switch is installed in coordination to intelligently control its use time. Replace fossil energy with new energy as much as possible, and use intelligent control system for regulation. Adopt a quality separated drainage system, clean the road, landscape greening, and flush the toilet with reclaimed water recycling. The buildings shall be installed with water-saving appliances to improve the hot bird effect by saving the design water of the water body, so that the water in the campus can be recycled. Select appropriate landscape types and planting density to achieve efficient carbon sequestration. Evaluate the value of parking spaces on campus from the perspective of carbon reduction through economic means. The parking fee varies according to the location. The parking fee increases from the periphery of the campus to the central area of the campus. The parking fee standard is determined according to the number of passengers. The more passengers, the more preferential the parking fee. Encourage the development and construction of environmental protection projects on campus, set up an interest free environmental credit fund, and campus teachers and students can obtain appropriate loans if they are recognized by the conservation project. The promotion of carbon footprint calculator and the appropriate release of personal carbon footprint information can also be used for restriction and supervision. Establish a green campus credit system, and give certain credit and material rewards to students who actively participate. Try to use local suppliers, reduce the supply of alcohol, cigarettes and other goods on campus, and reduce the repetition rate of similar carbon footprints in the process of purchasing materials. Do a good job in the daily maintenance of greening maintenance, shaping, campus cleaning, etc. A green volunteer association was established to carry out green campus publicity activities and green protection and pollution removal volunteer activities. Organize tree planting activities for teachers and students on tree planting day, Earth Day, World Water Day and World Environment Day.

5. Conclusions

Through the analysis of the current situation of carbon footprint of college students' behavior, this study clarifies the overall strategic direction of green campus construction based on carbon footprint under the background of low carbon economy, which can effectively improve the macro and micro level of low carbon in colleges and universities from top to bottom. On the macro level, we can intelligently control the use of campus resources or ener-

gy, repair and improve energy consuming buildings, and call on individuals to reduce the waste of daily necessities and reduce unnecessary living expenses. At the micro level, it is necessary to strengthen the utilization of electric power and energy, avoid the occurrence of electricity saturation, reduce the daily unnecessary use of products and the frequency of commodity purchase, reduce the number of high-energy transport trips, and change the mode of transport.

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