



Short communication

Survey of energy consumption and energy conservation measures for colleges and universities in Guangdong province



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ABSTRACT

As an important part of economical society, colleges and universities have been shouldering the important task of education, science research and social service. In this paper, a detailed investigation in the form of questionnaire was carried out for the energy consumption of colleges and universities in Guangdong Province, including electricity, water, gas and cooling energy consumption from 2006 to 2010. The energy meter reading modes, energy conservation investment amount and energy-efficiency retrofit work were also reported and analyzed.

Furthermore, as can be concluded from the survey, there exists great difference in per unit energy consumption between different types of universities classified by schools' discipline, nature and level, which would be taken into account when the energy consumption evaluation indexes system is established. Although energy-saving measures at Guangdong's colleges and universities bear fruit, Guangdong's colleges and universities still have great potential of energy conservation and emission reduction by Conservation-oriented campus construction, and the government should increase funding and improve economic policy to encourage and support energy saving for colleges and universities.

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1. Introduction

In the context of globalization, higher education has undergone tremendous expansion in the recent past, whose energy consumption has a large impact on both financial and environmental interests. Since the early 1990s, many partnerships have been established one after another as a result of the higher education for sustainability movement, which focus on energy efficiency, conservation and management for colleges and universities, including C2E2 (Campus Consortium for Environmental Excellence), ACUPCC (American College & University Presidents Climate Commitment), ISCEN (International Sustainable Campus Network), Higher Education's Commitment to Sustainability, etc.

In China, the rapid economic development also brought about the unprecedented growth opportunities in higher education. At the beginning of the 21st century for its first decade, colleges and universities began to realize the significance of energy conservation from human dimension in achieving a sustainable energy future. Several Schools partnership to improve energy conservation have been set up in China, such as NUECA (National University Energy

Conservation Alliance), UAIEE (University Alliance for Industrial Energy Efficiency), and CGUN (China Green University network). Moreover, the government also has paid unprecedented attention to energy conservation efforts and invested billions of U.S. dollars in Conservation-oriented Campus Construction Program, according to the MOHURD (Ministry of Housing and Urban-Rural Development of the People's Republic of China).

In order to promote energy conservation of Guangdong Province higher educational institutions, Director Jun-wen Zhu, of the Guangdong Provincial Department of Education Logistics Management Office, who is a co-author of the paper, conducted the survey.

This survey, in the form of a questionnaire, of energy consumption and energy conservation patterns for Guangdong higher educational institutions, was undertaken in the second half of 2011. More than 70% colleges and universities in Guangdong participated in this survey, of which the energy consumptions from 2006 to 2010, including electricity, water and gas, were investigated. The energy measurement methods, completed energy-efficiency retrofit work and energy conservation plan were also reported and analyzed.

The purpose of this survey is to clarify the status of energy consumption, identify and illustrate the weak links in energy efficiency for energy efficiency improvement. From this survey, it is then possible to analyze the emission reduction potential for greenhouse gases. Our study does not aim to find the major causes of energy

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waste, but rather to concentrate on the status of energy consumption and energy conservation, so the part on energy use patterns are omitted. This survey also helps to examine the details of the current state of energy saving measures, as the policy background of energy-saving.

2. Previous studies

By 2007, there were 2706 colleges and universities, with over 30 million students enrolled in mainland China, and it was estimated that roughly the annual energy consumption per student was 0.897 tces, which was more than four times national energy consumption per capita, while the annual water use per student was 145 ton, which was more than twice domestic water use per capita [1].

By the end of 2011, more than 200 Colleges and Universities had benefited from Conservation-oriented Campus Construction Program. Compared to the previous year, the average annual water use per student of 25 demonstration schools, of which Conservation-oriented Campus Construction had been carried out, is 69.36 ton which was 63% decreased [2], while the average annual electricity consumption per unit building area was 22.7 kWh/m² which was 23.3% decreased. That is to say, in China, the energy saving potential of colleges and universities is significant.

As China's economically developed areas and a great education province, Guangdong province has a humid subtropical climate, though nearing a tropical climate in the far south. The whole province boasted a total of 131 universities, with an enrollment of 438,600 undergraduate students and students of junior college level each year with 1,334,100 students at school by the end of 2010. For full-time postgraduate education, there was an enrollment of 24,500 students and a number of 65,900 students at school [3]. So far, due to lack of an effective data acquisition system, the datum on energy consumption of the colleges and universities had been mainly acquired manually. Thence, there was no exact information about energy usage of each higher education institutions of Guangdong before this survey.

To pursue the index and characteristic of energy usage per unit for different types of colleges and universities in subtropical region, two classification methods were applied to comparative analysis of water, electricity, and gas consumption. The first classification method in terms of school disciplines was developed by the Higher Educational Department of the Ministry of Education of Guangdong province to support its program of research and policy analysis. According to this method, the colleges and universities could be divided into 10 categories: Comprehensive University, Natural Sciences & Technology, Agriculture, Medicine & Pharmacy, Teacher Training, Language & Literature, Finance & Economics, Political Science & Law, Physical Culture, Art. The second classification method in terms of schools nature and level was also proposed from another point of view, according to which the colleges and universities could be divided into 4 sub-systems: Public & Undergraduate institutions, Public & Higher Vocational colleges, Private & Higher Vocational colleges, Independent & Undergraduate institutions.

3. Survey methodology

The questionnaire was designed from above study, that consisted of four sections including profiles of colleges and universities, energy consumption and methods for measuring energy consumption, completed energy-efficiency retrofit work and energy conservation plan. The items within the questionnaire were summarized in Table 1. The schools involved in this survey

Table 1
Items of the questionnaire sheet.

Part I	Profiles of colleges and universities
Part II	Energy consumption and methods for measuring energy consumption
Part III	Completed energy-efficiency retrofit work
Part IV	Energy saving plan

Table 2
Profiles of colleges and universities.

Name, address, total campus area, school type
Numbers of full-time students
Numbers of full-time employees (faculty/staff)
Number of buildings, total building area
Energy conservation management agency
Name and contact information of person in charge of energy conservation promotion

Table 3
Energy consumption and methods for measuring energy consumption.

Annual energy usage for water, electricity, cold, gas during the period of the Eleventh Five-year Plan (2006–2010)
Metering device for water, electricity, cold, and gas
Total metering, building-level sub-metering or end-use sub-metering for water, electricity, cold, and gas

Table 4
Completed energy-efficiency retrofit projects.

Implementation of completed energy savings projects
Total energy efficiency investments
Sources of funds
Renewable energy utilization
Other energy conservation measures

should fill the required information in the survey form as seen in Tables 2–5.

Energy consumption and methods for measuring energy consumption are the key focuses of this study in Table 3. Water, electricity, gas and cold are the major resources of all universities, while gas is the most commonly used in canteen and the cold is supplied by Guangzhou University City district cooling system is just consumed in which involves ten universities. For the four major types of energy, the meter reading modes could be divided into two forms: manual meter reading mode and automatic meter reading mode. With the rapid development of automation and measuring techniques, the manual meter reading mode has been gradually replaced by automatic meter reading mode. One of the main advantages of automatic meter reading technology is that the technology mainly saves utility providers the expense of periodic trips to each physical location to read a meter and another is that the billing could be based on near real-time consumption rather than on estimates based on past or predicted consumption which could help both utility providers and customers better control the use and production of electric energy, gas usage, or water consumption. So, metering reading mode and instruments for water, electricity, cold, gas were investigated. Furthermore, current status of sub-metering was stated in the questionnaire (Table 3), because it helped allocate costs appropriately by department, encourages conservation, produces more accurate energy reports and profiles.

Table 5
Energy saving action plans.

Evolution of energy efficiency financing and investment
Renewable energy action plan
Suggestions on further strengthening the work of energy conservation

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