Energy conservation in China’s higher education institutions

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HIGHLIGHTS
- A detailed study is conducted of energy conservation in eight HEIs.
- The HEIs implement comprehensive non-technical initiatives to conserve electricity.
- The HEIs are less enthusiastic in thermal energy conservation.
- The government is identified as the key initiator of energy conservation.
- Key challenges to energy conservation are identified.

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ABSTRACT
This paper analyzes the energy conservation situation in China’s higher education institutions (HEIs). A case study was conducted in Changchun, Jilin, where eight HEIs of various types were examined. An analysis of government policies was also performed. The findings indicate that the HEIs have implemented comprehensive non-technical initiatives to conserve electricity, including electricity restrictions and extensions of winter breaks, as well as certain technical initiatives. The HEIs are less enthusiastic in conserving thermal energy due to a lack of financial incentives and resources. Differences between the HEIs are also noted. This paper discusses the role of key players, including administrators, government agencies, networks, students and non-government organizations (NGOs). Challenges to energy conservation are also identified, such as the lack of investment by schools, lack of government funding, quality problems in energy conservation products, inadequate heat metering reform, underperformance of energy service companies (ESCOs), and conflicts between energy conservation and student welfare. Policy recommendations are offered based on the analysis results.

1. Introduction

Energy conservation in higher education institutions (HEIs) is an important component for sustainability for several reasons: HEIs are major consumers of energy; they are closely affected by problems caused by scarcity of non-renewable resources and climate change; they serve as educators; and rising energy costs have become a major impediment to growth in HEIs. Because of these reasons, HEIs around the world have become engaged in energy conservation. A small but growing body of research studies involves investigations into this trend. These studies have primarily originated in developed countries, such as the United States (Agarwal et al., 2009; James and Card, 2011; Marans and Edelstein, 2010), the United Kingdom (Alton, 2010) and Australia (Black et al., 2010). China’s HEIs have not been examined despite their status as significant energy consumers. According to Zhang Fulin, the head of Ministry of Housing and Urban–Rural Development’s Energy Conservation Division, China’s HEIs consumed approximately 29.24 Mtce of energy in 2008, or nearly 10% of the total residential energy consumption (Zhang, 2010). The reported total energy consumption from all UK HEIs in 2006 was 706.23 ktoe (Ward et al., 2008), which is equivalent to 1.01 Mtce. This pioneering work explores the energy consumption patterns and energy conservation interventions of HEIs in China, with a focus on electricity and thermal energy. Less significant forms of energy consumption, such as internal transportation, have been omitted for the sake of simplicity. Furthermore, this work identifies key players and challenges. To critically engage with the literature, the findings are compared and contrasted with international experiences. This study adopted a qualitative case study approach. Fieldwork was conducted in Changchun, which is the provincial capital of Jilin Province, from March to August 2012. Changchun was selected because of its large number of HEIs and the presence of contact. Information was obtained through interviews with HEI energy managers and...
government officials responsible for energy conservation, as well as through document analysis.

The next section provides a brief overview of the situation at Chinese HEIs. An analysis of both technical and non-technical energy conservation initiatives undertaken by the HEIs is provided in a subsequent section. Next, the key players are analyzed. This analysis is followed by a discussion about the energy conservation challenges of energy conservation faced by HEIs. The paper concludes with policy recommendations.

2. Chinese higher education sector: an overview

China’s higher education system has undergone profound reform in recent years. The definitive moment began in 1998, when extensive sector changes were implemented to transform higher education from an elite system into a mass system. Tuitions were introduced; management responsibility was redistributed from central to local governments (Wu and Zheng, 2008); existing HEIs expanded significantly, thousands of new HEIs were established (Chen and Wu, 2011); and adult higher education (Wang, 2011), distance higher education (Robinson et al., 2011) and private higher education (Li and Morgan, 2011) were introduced into the system. The purpose of the reforms was to increase the output of human capital and hence China’s global competitiveness, stimulate domestic consumption, reduce urban unemployment and fulfill public appeals for higher education (Wan, 2006; Wang and Liu, 2011). The result was a quantitative leap in the number of higher education students (Fig. 1). The growth rate was particularly strong from 1999 to 2004, when the sector experienced annual growth in excess of 20%. Although the trend slowed somewhat during the latter half of the 2000s, the growth rate remained substantially higher than the population growth rate. Now, more than ten years after the reform, China has by far the largest higher education system in the world. According to the latest figures, there are 2409 regular HEIs (of which 698 are private) and 353 adult HEIs, with a total enrollment of approximately 32 million students. The percentage of Chinese youth with access to higher education increased from less than 5% in the 1980s to 26.9% in 2011 (National Bureau of Statistics, 2011).

Despite their achievements, the reforms have resulted in many problems. The issues of social justice, unemployment rates of graduates and substandard teaching quality are particularly prominent. Although tuition fees have been remained stagnant for the majority of rural and low-income urban families (Yao et al., 2010). The per capita net income of rural and urban residents was 5919 RMB and 19,109 RMB respectively, in 2010 (National Bureau of Statistics, 2011). Although student loans were established, the take-up rate remains low due to various cultural and institutional barriers (Wang and Liu, 2011). Unemployment rates of graduates are another serious problem, and are a result not only of HEIs producing more graduates than the labor market can absorb but also of structural problems in the higher education system (Bai, 2006; Huber et al., 2011). Official statistics indicate that the level of unemployment among HEI graduates is approximately 20%. However, some researchers are optimistic about the future and argue that the problems are temporary (Li et al., 2011).

3. The eight studied HEIs and their energy consumption

Eight HEIs were selected to represent the different types of schools in China’s higher education sector. There are three types of HEIs in China, as characterized by their administrative structure:

1. Central-level HEIs: These HEIs are placed under direct control of the central government’s Ministry of Education (MOE). They are considered the top-tier of universities in China.

2. Provincial-level HEIs: These HEIs are under the control of provincial governments. This is the largest group of HEIs and is comprised of smaller local universities and 3-year vocational colleges.

3. Private and independent HEIs: These schools are either fully privately owned (private) or are managed through partnerships between the public and private sectors (independent). These schools do not receive funding from the government and thus charge higher tuition fees. Theoretically, both private and independent HEIs are autonomous; however, independent HEIs are still subjected to extensive government control in practice (Zhang, 2011).

A total of two central-level HEIs, four provincial-level HEIs, and one private HEI and one independent HEI were selected for this study. Table 1 lists the selected HEIs and their basic characteristics.

3.1. Electric energy consumption

China’s HEIs are not transparent about their levels of energy consumption; few schools regularly publicize up-to-date energy consumption data. Because none of the schools in this study publish their energy statistics, information from electricity bills was obtained from energy managers to calculate electricity consumption. To compare the HEIs, data on electricity consumption is combined with student numbers and gross floor area (GFA) to calculate electricity intensity. Fig. 2 presents the variation in terms of electricity consumption per student among different HEIs. In addition to the investment in energy conservation, electricity intensity appears to be influenced by at least two factors. The first factor is the level of facilities provided by the schools. JU, for instance, is well known for its spacious and well-equipped campuses, which contribute to its high energy consumption per student. The second factor is the specialization of school. An engineering school is likely to have higher electricity intensity than a humanity school. This partly explains the high electricity intensity of CUST, Changchun’s leading engineering HEI. However, the schools have a similar level of electricity consumption per floor area (Fig. 3). Perhaps, this is because most schools are applying similar practices to control electricity consumption per floor area.
When compared internationally, the HEIs consume lower levels of electricity. This is partly because Changchun is located in Northeast China where the temperatures rarely rise above 30 °C in summers. Therefore, few buildings are equipped with electric fans or air conditioners. Another key reason, as discussed in the next section, is that the schools have made substantial efforts to lower electricity usage. Because of data limitations, part-time students have not been incorporated into the dataset. The enrollment of part-time students can be significant. For instance, JU enrolls 16,663 mature-age students and 46,507 remote-learning students. Therefore, electricity consumption per full-time equivalent (FTE) may be substantially lower than electricity consumption per student.

### 3.2. Thermal energy consumption

The statistics presented previously are concerned with electric consumption. A significant amount of energy at HEIs in China’s northern provinces is used for space heating. None of the HEIs have reliable data on thermal energy consumption because heating is billed based on space rather than on energy consumed. To estimate thermal energy consumption, an energy intensity of 177 kWh/m² is assumed. After incorporating thermal energy, total energy consumption per student is 6759 kWh/year, and total energy consumption per m² GFA is 204 kWh/year. These figures are similar to HEIs in developed countries. For example, in the UK in 2006, energy consumption per student was 6346 kWh/year and energy consumption per m² GFA was 287 kWh/year (Ward et al., 2008). The high energy consumption for space heating is mainly due to poor insulation of building envelopes (Lv et al., 2009), which is a result of ineffective building energy codes (Li et al., 2009). Moreover, the winter heating period in Changchun is one of the longest heating periods in China due to long winters; this weather condition contributes to high thermal energy consumption. Finally, the government prohibits students who receive higher education from living off campus because it considers dormitories important sites for social, political and ideological education. Finally, the government prohibits students who receive higher education from living off campus because it considers dormitories important sites for social, political and ideological education (Mooney, 2005). The need to accommodate a large body of students is another factor in high thermal energy consumption during the winter.

### 4. Energy conservation intervention

#### 4.1. Non-technical initiatives

The HEIs share many similarities among the non-technical energy conservation initiatives that they have adopted. The main focus has been on electricity, particularly electricity consumed in student dormitories, whereas thermal energy has not received adequate attention. Five groups of mechanisms have been almost universally adopted. The first group is the institutionalization of energy conservation, which includes the establishment of a leading high-level energy conservation group responsible for long-term planning, and the creation of energy conservation office for managing daily operations, while incorporating energy conservation into staff evaluations and staff recognition for excellent energy conservation efforts.

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1. This estimation is based on a recent survey of Changchun’s heating companies, which reports a thermal energy intensity of 250 kWh/m²/year. Since the winter break for HEIs in Changchun usually consists of 7 weeks, during which heat is not supplied, the energy consumption is reduced by 49 days/167 day-s = 29.3% (Bai and Ai, 2010). A survey of coal-fired heating boilers in Changchun. Journal of Jilin Architectural and Civil Engineering (Chinese) 2010-01.
The second group of energy conservation mechanisms targets student dormitories and involve charging students for services that were originally provided for free; this original practice was believed to lead to wasteful behavior. The HEIs have installed electricity meters in their dormitories since 2008 to measure electricity consumption, and charge students fees if certain limits were exceeded. Moreover, pay showers were installed to discourage students from taking excessively long showers. Students use IC that automatically stores the duration of the shower and calculates fees accordingly. Charging for hot drinking water is a less common practice; and only two schools have implemented such a measure. The third and related group of energy conservation measures is electricity restriction. For example, the electricity restriction policy introduced by JU in 2009 includes the following six clauses:

1. The period of electricity cutoff is from 23:30 to 06:00.
2. Each room can consume a total of 20 kWh per month free or charge. In addition, each undergraduate can consume 1 kWh per month; each graduate student can consume 3 kWh per month; and each PhD student can consume 4 kWh per month.
3. Electricity usage that exceeds the above-mentioned limits will be charged a fee of 0.525 RMB/kWh.
4. Each room has a maximum power of 2500 W, which automatically powers off if this usage is exceeded.
5. The limit for resistance heaters is 550 W. They automatically power off if this usage is exceeded.
6. Students are prohibited from using high-power appliances (e.g., electric heaters, kettles and electric blankets).

The extension of winter breaks, a measure that has been recently adopted by many schools in northern China to conserve energy (Dazhong Daily, 2009), is the fourth group of energy conservation measures that have been taken by many schools in northern China to conserve energy. Solar water heating is also a popular measure for electricity conservation in the higher education sector, particularly since 2006 when energy conservation became a national priority (Yuan et al., 2011; Yuan and Zuo, 2011). The key policies are detailed as follows:

Constructing Efficient Schools: In 2006, the MOE promulgated the “Notice on Constructing Efficient Schools” (Ministry of Education, 2006). The policy urges HEIs to conserve energy, water, materials and land, and included seven demands for HEIs: formulate long-term plans for conservation; adopt conservation technologies; incorporate conservation into daily management and promote awareness of conservation. In 2008, the MOE and Ministry of Housing and Urban-Rural Development (MHURD) jointly released the “Opinion on Constructing Efficient Schools through Energy and Water Conservation”. The policy established a new target for reducing energy consumption among HEIs by 15% in five years, and included three additional demands for HEIs: strengthen energy consumption monitoring; ensure that new buildings conform to energy standards; establish leading energy conservation groups and energy conservation offices. However, the impact of these policies is potentially limited due to a lack of concrete implementation and monitoring mechanisms.

Campus Conservation Demonstration Project: This project is aimed at promoting the use of building energy management systems (BEMS), which are computer-based systems that monitor and control building equipment that consumes energy. In December 2008, the MOE, MHURD and Ministry of Finance (MOF) designated 12 HEIs as demonstration schools. A total of 45.8 million RMB was allocated to finance the establishment of BEMS at HEIs. In 2009, the MHURD and MOE released the “Higher Education Institutions Campus Building Energy Management System Development Guideline”, which contains detailed instructions about BEMS for implementation by the schools. Thus far, the program has supported 144 HEIs with total funding in the amount of approximately 0.5 billion RMB (Zhang, 2012). The number of HEIs that have benefited from this program is quite small considering that there are nearly 3000 HEIs in China. JU is the only HEI of this study that has established a BEMS for one of its campuses.

### 5. Key players

#### 5.1. Government

The role of the government for energy conservation in HEIs is rarely mentioned in the literature. One notable exception is Altan (2010), who reports that HEIs in the UK are subjected to five pieces of legislation and regulations at the national and European levels: EU Emissions Trading Scheme, Climate Change Levy, Part L Building Regulations, EU Environmental Performance of Building Directive, and Carbon Reduction Commitment. The Chinese government plays an important role in championing and supporting energy conservation in the higher education sector, particularly since 2006 when energy conservation became a national priority (Yuan et al., 2011; Yuan and Zuo, 2011). The key policies are detailed as follows:

Construction of Energy Conservation Office: This project is aimed at promoting the use of building energy management systems (BEMS), which are computer-based systems that monitor and control building equipment that consumes energy. In December 2008, the MOE, MHURD and Ministry of Finance (MOF) designated 12 HEIs as demonstration schools. A total of 45.8 million RMB was allocated to finance the establishment of BEMS at HEIs. In 2009, the MHURD and MOE released the “Opinion on Constructing Efficient Schools through Energy and Water Conservation”. The policy established a new target for reducing energy consumption among HEIs by 15% in five years, and included three additional demands for HEIs: strengthen energy consumption monitoring; ensure that new buildings conform to energy standards; establish leading energy conservation groups and energy conservation offices. However, the impact of these policies is potentially limited due to a lack of concrete implementation and monitoring mechanisms.

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### 4.2. Technical initiatives

The HEIs employ very different technical energy conservation initiatives. While the resourceful, central-level schools are able to invest in a wide variety of projects, the smaller schools are limited to low-cost or government-subsidized projects. The most popular technical initiatives for electricity conservation are measures that target lighting, including LED and solar powered street lighting, compact fluorescent lighting and infra-red lighting controls. Although all schools have invested in these measures in various degrees, none have completely revamped their campuses with renewable or energy efficient lighting. Solar water heating is also popular. Because of low water temperatures during the winter, solar water heating systems are used in combination with electricity heat to deliver sufficient amounts of hot water. Solar water heating has been reported to result in as much as to 30% energy conservation savings. Other less common electricity conservation measures include: real-time energy monitoring systems (JU), voltage reduction (NENU) and energy efficient transformers (NENU).

The HEIs have spent considerably less effort and money on thermal energy conservation. The most popular measure for heating conservation is building insulation. Some of the older buildings without insulation have been retrofitted with polystyrene insulation and double-glazed windows. As an exception rather than the norm, JU invested substantially in heat transfer stations and pipework renovations, which resulted in approximately 5% energy conservation savings.
Building Retrofit Project: To address the problem of inadequate insulation in existing buildings, the MHURD and MOF demanded that the 15 northern provinces retrofit their energy inefficient buildings in 2007, and supported them with a subsidy in the range of 45–55 RMB/m² (Ding et al., 2011). However, it was not until 2010 that the Jilin Provincial People’s Government fully implemented the program. The plan for Changchun was to retrofit 6 million m² of energy-inefficient buildings at the expense of the government (Changchun Municipal People’s Government, 2010). However, the higher education sector is not the focus of this program, with only a small number of schools benefiting from the program.

Building Energy Codes: The central government introduced building energy codes in 1986. In 2008, the MOHURD updated the codes, which require 65% improvement in energy efficiency from buildings constructed prior to the inception of codes. However, the implementation was insufficient. The majority of buildings in the HEIs, even those built as late as 2009, do not contain any type of insulation. It was not until 2010 that the building energy codes began to be enforced with the release of the “Changchun Municipal Civil Buildings Energy Efficiency Management Method”. The enforcement has proved to be effective and all new buildings of the HEIs have complied with the current energy efficiency standard.

Public Institution Energy Conservation Program: In 2009, Jilin Province People’s Government (JPPG) promulgated the “Method of Energy Conservation in Jilin Province Public Institutions”, a command-and-control program that targets provincial-level public institutions. Because all but three HEIs (JU, NENU and JHFLI) are under jurisdiction of the provincial government, the program is influential in promoting energy conservation behaviors among the HEIs. As illustrated in Table 2, JPPG stipulated 32 tasks (22 tasks if trivial tasks are omitted), and a demand of reducing energy intensity by 2% each year. None of the tasks are mandatory, but completion of each task yields certain points in the yearly evaluation; therefore, it is important for HEIs to complete a high percentage of the tasks to pass their assessment. The HEI with the highest score is rewarded with a certificate and 10,000 RMB. HEIs that fail the evaluation (scoring less than 60 out of 100) are asked to submit an improvement proposal within one month. High levels of compliance have been reported for the past three assessments, with the majority of HEIs scoring above 80.

Ten-Thousand Enterprise Energy Conservation Program: Launched in 2011, the Ten-Thousand Enterprise Energy Conservation Program, which is a national policy created by the National Development and Reform Commission (NDRC), is similar to the Public Institution Energy Conservation Program. It is a command-and-control policy with 27 tasks; schools regulated by the program have to complete specified energy conservation targets or risk punishment (National Development and Reform Commission, 2011). There is substantial overlap between the two programs with approximately half (13) of the tasks in the Ten-Thousand Enterprise Program comprised of new tasks, such as energy audits, establishment of certified energy managers and elimination of outdated equipment. The key difference is that the Ten-Thousand Enterprise Program places a greater focus on target achievement. Not only do the targets constitute 40% of the entire assessment scheme (compared with 25% of targets in the Public Institution Program) but failure to achieve the targets would automatically cause a failure of the entire assessment. Punishment includes compulsory energy audits, disapproval of future energy-intensive projects and loan restrictions.

5.2. Administrators

Internationally, school administrators are often important champions of energy conservation because they can command resources and possess the authority to conduct initiatives that can have a significant impact on energy consumption levels (Brinkhurst et al., 2011). Although administrators in China’s HEIs also play a significant role in driving the energy conservation agenda, their commitment is less ambitious, and they are mainly concerned with reducing the operational costs of the school.

5.3. Networks

Networks have played an important role in promoting energy conservation in the higher education sector, mainly as a disseminator of information. An internationally renowned example is the American College & University Presidents’ Climate Commitment (ACUPCC). Two government-sponsored networks play a similar role in Changchun. First, the Jilin Higher Education Institution Back Office Association (JHEIBOA) was established in 2009 by 55 HEIs in the province. The association notifies its members about new technologies and funding opportunities, as well as about organizing energy conservation seminars and presenting awards to HEIs that exhibit exemplary performance in energy conservation. The second network is the National Higher Education Institution Energy Conservation Union (NHEIECU). Established in 2010, the network is comprised of 100 of the largest HEIs nationwide, each of which has vowed to implement ten key energy conservation projects on their campuses.

5.4. Students

Internationally, students are regarded as important agents of campus change with regard to environmental issues (McIntosh et al., 2008). Studies find that grassroots (bottom-up) efforts often precede official actions (James and Card, 2011). Student advocates organize and launch energy conservation efforts such as bicycle campaigns, Green Weeks, voluntary energy assessments, voluntary sustainability fundraisers, residence challenges, and student-funded energy efficiency and renewable energy projects (Helferty and Clarke, 2009). In comparison, the Chinese students are less actively involved in energy conservation. While the eight HEIs have all established some form of student environmental protection organization (for instance, NENU students established the NENU Green Power Environmental Protection (Volunteer) Association in 1993), their functions are limited to awareness-raising. Moreover, because the student organizations cover general environmental issues, only minimum effort is diverted to energy conservation issues.

5.5. Non-government organizations (NGOs)

NGOs are another key contributor to energy conservation in international HEIs. For example, Helferty and Clarke (2009) reported that the Sierra Youth Coalition, which is the youth branch of Sierra Club Canada, supported students in 65 Canadian HEIs in making their campuses more sustainable. China’s NGO sector is complex. Because the official requirement of obtaining official government sponsorship is difficult to meet for both international and domestic NGOs, the majority of NGO are either unregistered or registered as a business entity (Wang and He, 2004). Thus far, the government has tolerated this development by adopting a “no recognition, no banning, no intervention” policy (Deng, 2010), but the legal status of NGOs in China is unclear, which has limited the development of NGOs. In Changchun, there are two NGOs that work with HEIs on energy conservation issues in a limited capacity: Worldwide Funds (WWF) and the Hong Kong Environmental Protection Association (HKEPA). WWF collaborates with environmental student organizations to promote its renowned Earth Hour program. HKEPA, through its affiliation with the China University Environmental
Table 2
Assessment criteria for Public Institution Energy Conservation Program.

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td>Energy conservation targets (25 marks)</td>
<td>Reduce energy consumption by 2% (25 marks)</td>
<td>5 marks for every task accomplished: petrol consumption per car, electricity intensity, water intensity, gas intensity and expenditure on office supplies</td>
</tr>
<tr>
<td>Organization and leadership (6 marks)</td>
<td>Organization and leadership (2 marks)</td>
<td>1 mark for establishing an energy conservation leading group; 1 mark for establishing an energy conservation office</td>
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<tr>
<td></td>
<td>Leadership involvement (2 marks)</td>
<td>1 mark for every energy conservation instruction given by key leaders</td>
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<tr>
<td></td>
<td>Energy conservation plan (2 marks)</td>
<td>1 mark for establishing a plan, 1 mark for summarizing experience</td>
</tr>
<tr>
<td>Planning (2 marks)</td>
<td>Energy conservation targets (1 mark)</td>
<td>1 mark for determining energy conservation targets</td>
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<td></td>
<td>Report (1 mark)</td>
<td>1 mark for reporting the target to Jilin Province Energy Conservation Office (JPECO)</td>
</tr>
<tr>
<td>Awareness-raising and training (8 marks)</td>
<td>Training (2 mark)</td>
<td>1 mark for every training program for staff or students</td>
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<tr>
<td></td>
<td>Awareness-raising (3 marks)</td>
<td>1 mark for organizing low-carbon living activities; 1 mark for participating in the National Energy Conservation Week; 1 mark for reporting results to JPECO</td>
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<tr>
<td></td>
<td>Energy conservation newsletters (2 marks)</td>
<td>0.5 mark for every publication</td>
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<tr>
<td></td>
<td>Composition competition (1 mark)</td>
<td>1 mark if an essay is awarded first class honor; 0.5 mark for second-class honor; 0.3 for third-class honor</td>
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<tr>
<td>Statistics (15 marks)</td>
<td>Statistic officer (2 marks)</td>
<td>1 mark for designate staff responsible for collecting energy consumption statistics; 1 mark for setting up a handover system</td>
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<tr>
<td></td>
<td>Report (2.5 marks)</td>
<td>0.5 mark for each quarterly and annual energy consumption report</td>
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<tr>
<td></td>
<td>Quality of statistics (2 marks)</td>
<td>0.5 mark each if statistics meet the following criteria: true, complete, accurate and match</td>
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<td></td>
<td>Analysis (3.5 marks)</td>
<td>0.5 mark for each analysis report submitted; 1 mark if all analysis reports are submitted to JPECO</td>
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<tr>
<td></td>
<td>Publicize statistics (3 marks)</td>
<td>2 marks for publicizing building energy consumption and automobile oil consumption statistics</td>
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<tr>
<td></td>
<td>Statistics bulletin (2 marks)</td>
<td>1 mark if the bulletin is circulated within the entire government system, 0.5 if the bulletin is only circulated at provincial level</td>
</tr>
<tr>
<td>Communication (5 marks)</td>
<td>Communication officer (2 marks)</td>
<td>1 mark for designating staff responsible for communication; 1 mark for setting up a handover system</td>
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<td></td>
<td>Communication meetings (1 mark)</td>
<td>1 mark for participating in provincial communication meetings</td>
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<td></td>
<td>Exchange work information (2 marks)</td>
<td>0.5 mark for each article published in the JPECO energy conservation newsletter</td>
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<tr>
<td>Energy management (18 marks)</td>
<td>Energy management system (2 marks)</td>
<td>0.5 mark for the establishment of every management system (water, electricity, petrol and gas)</td>
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<td></td>
<td>Ledger (2 marks)</td>
<td>2 marks for using the provincial standard ledger to record energy consumption</td>
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<td>Signage (1 mark)</td>
<td>1 mark for displaying energy conservation signs at work place</td>
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<td></td>
<td>Target responsibility system (2 marks)</td>
<td>2 marks for breaking down targets to sub-units</td>
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<td></td>
<td>Quota management (4 marks)</td>
<td>2 marks for setting energy consumption quotas; 2 marks for reporting to JPECO</td>
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<td></td>
<td>Energy service companies (ESCos) (4 marks)</td>
<td>2 marks for conducting every ESCO project</td>
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<tr>
<td></td>
<td>Energy-efficient equipment (3 marks)</td>
<td>1 mark for using only energy-efficient lighting; 1 mark for using only energy-efficient stoves; 1 mark for using only water-saving equipment</td>
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<tr>
<td>Supervision (6 marks)</td>
<td>Appraisal standards (2 marks)</td>
<td>2 marks for establishing appraisal standards</td>
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<td></td>
<td>Check (2 marks)</td>
<td>1 mark for conducting every check</td>
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<td></td>
<td>Circulate check results (2 marks)</td>
<td>1 mark for each circulation of results</td>
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<tr>
<td>Technical intervention (10 marks)</td>
<td>Building energy audit (1 mark)</td>
<td>0.5 mark for conducting every energy audit</td>
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<td>Retrofit buildings (5 marks)</td>
<td>1 mark for every project that is over 500,000 RMB</td>
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<td></td>
<td>Renewable energy (4 marks)</td>
<td>1 mark for every project that is over 500,000 RMB</td>
</tr>
<tr>
<td>Energy conservation fund (5 marks)</td>
<td>Investment (5 marks)</td>
<td>5 marks for investing over 1,000,000 RMB; 3 marks for investing 500,000–1,000,000 RMB; 1 mark for investing under 500,000 RMB</td>
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Protection Association (CUEPA), collaborates with environmental student organizations to organize and fund awareness-raising activities.

6. Challenges to energy conservation

6.1. Lack of school investment

Budgetary constraints are significant challenge to energy conservation. While the two central-level HEIs invest approximately 10 million a year in energy conservation with their own capital, smaller schools invest approximately 100,000 to 300,000 RMB. This lack of investment is due to a combination of schools’ dire financial situations and the lack of commitment from its administrative leaders, whose support for energy conservation is based on its potential cost savings. The reasons for the dire financial situations at most schools are twofold. First, government investment in education is inadequate. Not only is there a lack of overall investment, but investments are highly skewed toward central-level HEIs. Second, almost all HEIs are under tremendous financial pressure because of debts incurred by the expansion policy discussed previously. Because of a lack of government funding, HEIs have been forced to secure loans from state banks to
finance their expansions. The debt of the higher education sector is estimated to reach as high as 400–500 billion RMB (Halachmi and Ngok, 2009).

6.2. Lack of government funding

Government funding constitutes an insignificant portion of total energy conservation investment in the eight HEIs, which reflects the difficulty of securing government funding for energy conservation. JU has received 12 million RMB in funding since 2008, but most schools have received much less or no funding. Central-level HEIs (i.e., JU and NENU) can apply for funding from the central government through the annual round of central-level maintenance and procurement funds, whereas provincial-level HEIs must apply for funding through the provincial government. Since 2008, priority funding has been allocated to energy conservation projects. However, the biggest hurdle is that governments require the schools to assume a minimum of 20% of the project cost. This 20% rule greatly reduces the enthusiasm of HEIs. NENU, for example, prepared all necessary documents for applying for funding for a real-time energy monitoring system, but have not submitted the application due to insufficient funds. Moreover, while the central-level HEIs obtain funding with relative ease, smaller schools can apply for years without one successful application. An additional problem is the timing of the funding. After an application is granted, it often takes months for the funding to be delivered to the school. This often causes delays of up to one year for projects. Lastly, the central government established a special fund to subsidize enterprises and schools in the Ten-Thousand Enterprise Program at a rate of 240 RMB/tce for eastern provinces and at a rate of 300 RMB/tce for central and western provinces. However, the requirement that the project must effectively save over 5000 tce excludes the majority of HEIs from this funding opportunity.

6.3. Low quality products

One common experience of the HEIs is that they invest in poor-quality energy conservation products, which depresses support from administrative leaders because the projects fail to deliver on their cost-saving promises. Solar-based technologies are frequently cited as problematic; however, other technologies, such as infra-red sensing and IC cards for pay showers are also occasionally mentioned. For instance, one school installed solar street-lighting in 2010. By 2012, the majority of the lighting has had stopped working. The poor quality of energy-efficient and renewable-energy products is not isolated, highlights widespread quality problems in China’s poorly regulated manufacturing industries, and is related to the institutional weaknesses of the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), which is China’s premium quality control agency.

6.4. Inadequate heat metering reform

Most of the HEIs purchase space heating from a heating company. Because heating fees are based on floor space, rather than on the amount of heat consumed, the HEIs lack incentives to improve the insulation in their buildings. Heat metering reform is intended to address this incentive problem. While the central government has introduced plans and targets that promote heat metering and temperature control equipment, the implementation process has been inadequate, with reform completed for less than 1% of the targeted floor area (Price et al., 2011). The main reasons are that the reform is complicated, may require extensive modification to existing buildings, and may lead to disputes regarding the way fees are calculated (Liu et al., 2011). Moreover, heat supply companies, which are key players in this activity, lack motivation because the reform is costly and primarily benefits the end-users.

6.5. Underperformance of ESCO

One increasingly popular alternative among HEIs that have small budgets is enlisting the help of energy service companies (ESCOs) (Carlson, 2010). ESCOs provide comprehensive solutions for improving energy efficiency and help to overcome financial and technical constraints on energy efficiency investments (Marino et al., 2011). To support the energy services industry, the MOF and NDRC introduced a subsidy in 2011 for energy conservation projects run by ESCOs, at a rate of 300 RMB/tce of energy saved (Ministry of Finance, National Development and Reform Commission, 2011). However, ESCOs are unable to realize their full potential in China because of market, institutional, financial and technological barriers (Gan, 2009). Energy managers at HEIs perceive dealing with ESCOs risky, because of uncertainty over the amount of energy conservation and a lack of trust. Kostka and Shin (2013) argue that this lack of trust is a key explanation for the underperformance for ESCOs in China. Another factor contributing to the underperformance of ESCOs in the higher education sector is low profitability due to limited room for improvement, and the realization that HEIs pay electricity at the residential rate (0.525 RMB/kWh) rather than at the higher commercial rate (0.947 RMB/kWh). Because of these problems, none of the eight HEI has engaged in ESCO projects.

6.6. Conflicts between student welfare and energy conservation

Some of the energy conservation policies have a detrimental impact on student welfare. One case is the electricity restriction policy. Students’ daily lives are severely disrupted by prohibiting high-power appliances and cutting off electricity for extended periods of time. In a recent survey, 73.7% of students viewed energy conservation on campuses as important, but only 14.1% of students were satisfied with the way energy conservation was achieved (Nanjing University of Aeronautics and Astronautics, 2008). In addition to feeling that their quality of life was negatively affected, the students also felt that energy conservation did not benefit them, although their implementation had saved substantial amounts of money for the schools. Although the survey is limited in scope, the problems it highlights have universal applicability across most HEIs in China.

7. Discussion and conclusion

What are the policy implications of the research? One of the findings is that although the schools have implemented comprehensive non-technical energy conservation measures, their investment in technical measures is limited by a lack of funding. Therefore, there is a need for increased government funding, as well as removal of the demand that schools must assume part of the project cost. In addition, HEIs should be exempt from the minimum energy conservation requirement for receiving funding through the Ten-Thousand Enterprise Program. More financial support is needed to promote ENSOs. To strengthen incentives for ESCOs to work with the higher education sector, the government may need to consider offering HEI-related projects with higher levels of subsidy than the standard 300 RMB/tce. Moreover, accelerating heat meter reform is important to provide HEIs incentives to improve the energy efficiency of their buildings. The analysis also suggests that addressing the country’s
deficiency in quality control will positively affect the energy conservation effort in the higher education sector, and possibly in other sectors as well.

Last, the study reveals that some of the energy conservation measures have created conflicts between the schools and their students. This is detrimental to the sustainability of energy conservation because it dampens student enthusiasm for energy conservation. There may be a need to modify energy conservation practices that severely affect the daily lives of students. The schools should also consider sharing the benefits of energy conservation with their students, for instance, by lowering dormitory fees or establishing energy conservation rewards. The government can require such efforts through the Public Institution Energy Conservation Program or the Ten-Thousand Enterprise Energy Conservation Program by including student welfare or compensation as evaluation indicators.

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