

Green Campus as a Pilot Site Towards Low-Carbon City: Enlightenment from Cornell Climate Action Plan

Tian-ren Yang

Abstract After green building initiative, much more attention has been paid to green campus transformation. Green campus serves as a pilot site for low-carbon city. This paper summarized the development process of green campus while analyzed the current situation of China's green campus initiative, including overemphasis on energy efficiency of single building, lack of integrated campus efficiency monitoring system, and insufficient financial support. Based on the experiences and enlightenment from Cornell University's Climate Action Plan, the sustainable development of green campus in China has been discussed, in the aspects of single building, community/campus, and city. On building level, campus building energy technology demonstration should be strengthened and popularized. On community/campus level, regulatory agencies should be established to take charge of low-carbon campus overall planning and monitoring. On city level, campus, as a regional experimental field of sustainable development, should promote low-carbon transformation of the city in specific ways.

Keywords Green campus · Low-carbon city · Climate action plan · Cornell University

1 Introduction

Currently, the necessity of developing green buildings has been widely recognized across the world. When green buildings are developing vertically and horizontally in all countries, the development of green campuses has become a key direction for

T. Yang (✉)
College of Architecture and Urban Planning, Tongji University,
1239 Siping Rd, Shanghai 200086, People's Republic of China
e-mail: tianren.yang@hotmail.com

T. Yang
College of Architecture, Georgia Institute of Technology, Atlanta 30332, USA

© Springer-Verlag Berlin Heidelberg 2015
S. Feng et al. (eds.), *Low-carbon City and New-type Urbanization*,
Environmental Science and Engineering, DOI 10.1007/978-3-662-45969-0_19

transforming green buildings in a mature way. The campus, where it is equipped with a great deal of building facilities as well as living facilities and scientific research facilities, is a big energy consumer in the society. Meanwhile, the campus is undertaking the great responsibility of training talents for the society and leading sustainable development of the society as a key field for educating people and developing technologies. Therefore, in order to achieve a sustainable development of universities and even the whole society in future, it is significant to construct a resource-saving, environment-friendly, and green college campus and to incorporate the idea and practice of sustainable development into various areas, such as college teaching, scientific research, talent training, and social service (Tan et al. 2012).

As an experiment plot and demonstration area of ecological city construction and a complete system in the social ecological system, green campus is featured with certain independent ecological functions while being closely related to surrounding ecological, economic, and social systems. With the in-depth development of the construction of green campuses, however, the sustainable development of campuses has been stuck in bottleneck. Moreover, it is an important period for China to develop green buildings, ecological cities, conservation-oriented campuses, and green campuses (Tan 2013). This paper is aiming at exploring and discussing technical paths for achieving sustainable development of green campuses in three levels [building–community (campus)–city] through concluding successful experiences from the development process while referring to experiences and enlightenment of Cornell University from “Climate Action Plan” for solving the bottleneck problem in the process of constructing and developing green campuses in China.

2 Development Process of Green Campuses

So far, the process of developing international green campuses can be concluded into five stages: the initial stage for environmental protection education, the stage for developing sustainable education, the stage for practicing green campus, the stage for demonstrating green campus, and the stage for promoting green campus (Table 1).

1. Environmental protection education. The concept of green campus was originally proposed in The Stockholm Declaration published by the United Nations Human Settlement Assembly in 1972. The declaration has raised concerns about environmental protection education in the society.
2. Developing sustainable education. In 1990, John Mayer from France made The Talloire Declaration, advocating for a 10 action plan that integrates sustainable development with college teaching, scientific research, operation, and publicity. It is the first official commitment made by a university administrator about sustainable education in colleges and universities. In 1994, UNESCO proposed to incorporate the idea of sustainable development into school education and

Table 1 Development process of green campuses

Year	Event	Key topic	Stage
1972	The Stockholm Declaration	Education of general knowledge on environmental protection	Environmental protection education
1990	The Talloire Declaration	Sustainable education of colleges and universities	Developing sustainable education
1994	EPD program (UNESCO)	Incorporate environmental education into development education, population education, etc	
1997	Thessaloniki meeting in Greece (UNESCO)	Sustainable education	
1997	Pilot project of green university	Construction of the pilot project	Practicing green campus
2006	AASHE	A system for tracking, assessing, and commenting sustainable development	Demonstrating green campus
2007	ISCN	Sustainable campus	
2007	ACUPCC	Declared to construct the campus of colleges and universities into a “carbon neutrality” park	Promoting green campus
2010	The centre for green schools (USGBC)	Work with people in the area of education to promote the construction of “green campus” upon built environment	

launched the EPD program. In 1997, UNESCO convened a meeting in Thessaloniki (Greece); in the meeting, the idea of “sustainable education” was defined, which indicates that environmental education was no longer education on environmental problems, but that it began to combine with education on peace, development, and population to form a philosophy of “sustainable development education.”

3. Practicing green campus. In 1997, some colleges and universities in the United States, out of a purpose to improve environmental protection consciousness and promote sustainable development education practice and campus construction, launched the Campus Consortium for Environmental Excellence (C2E2), a non-profitable organization or alliance. Supported by the United States Environmental Protection Agency (EPA), the alliance began to construct pilot projects vigorously. In the same year, the George Washington University (GWU) began to practice its pilot project for constructing a green university with a view to making the university the first green university in the world.
4. Demonstrating green campus. In 2006, colleges and universities in the United States and Canada co-founded the “Association of the Advancement of Sustainability in Higher Education” (AASHE), which developed “the Sustainability Tracking, Assessment and Rating System” (STARS). With this system, every college or university can self-evaluate its sustainability and make corresponding development policies by based on the evaluation report. In April of 2007,

Switzerland established an International Sustainable Campus Network (ISCN) with a view to constructing a platform for sharing experiences and information on how to construct sustainable development colleges and universities in a global range.

5. Promoting green campus. In June of 2007, the United States' practice of including sustainable development into operation and course practice in colleges and university yielded its most important result, that is, "the American College and University Presidents' Climate Commitment" (ACUPCC). ACUPCC was joined by 284 American college and university presidents who then jointly declared to construct college campus into a "carbon neutrality" park and try to reduce the direct or indirect emission of carbon dioxide through planting trees, saving energy, using renewable energy, and other ways. In 2010, USGBC founded the Centre for Green Schools, which was targeting at promoting the construction of "green campus" with people in the field of education upon the built environment.

After that, concepts such as "Eco-campus" and "Sustainable campus" began to appear one after another in the process of constructing college campus. From environmental education course to in-depth exploration on the idea of green colleges and universities, the content of constructing green colleges and universities was perfected constantly.

Under the background of new urbanization, colleges and universities are closely connecting to cities (Cornell University 2013). Therefore, the construction of green campus will enter a new stage with the construction of low-carbon cities. Green campus will not only cover content on planning, architecture, and landscape, but that comprehensive and integral consideration should be given to its urbanism and sociality. In future, the development of green campus will primarily be presented in the following areas: (1) The sustainable development idea should be included into the talent training systems of colleges and universities; (2) green and environmental protection technology innovation will become an important field of academic researches; school facilities, along with innovation of energy-saving and emission reduction technologies and their research, development, and promotion, will be featured with great potential; (3) colleges and universities will pay attention to the radiation influence of green campuses on the society and surrounding communities so as to actually turn green campus into a pilot place and demonstration area of ecological city construction.

3 Existent Problems on Practicing Green Campus in China

3.1 Focus on Single Building Mostly

Currently, the practice of green campus in China tends to regard single building as starting points, which has resulted in the absence of overall grasp over various spatial elements between buildings and open spaces. Meanwhile, too much

attention to indoor environment of campus buildings is likely to lead to an overlooking over comfort of outdoor environment. Furthermore, green campus is often considered in an isolated way in the overall city ecological framework, with little emphasis on positive interaction between campuses and surrounding cities, society and ecology and a lack of systematic consideration to its matching with infrastructure construction in surrounding areas.

3.2 Low Level of Campus Management Efficiency

Since a campus has many buildings, the need for energy grows rigidly and the energy consumption and water consumption per student in the campus are higher than the average level of urban residents. Under the background when China is adjusting its social and economic industrial structures while transforming and developing its industrial production structure, the total energy consumption of the campus is increasingly taking a bigger and bigger proportion of the total energy consumption of the society. In China, however, colleges and universities are public institutes funded by the central or local governments. As a result, a severe shortage of energy-saving consciousness and energy cost-control consciousness has been existing in these places for a long time. Moreover, there is not a comprehensive and systematic sustainable development and construction standard for campus energy consumption management in levels from management to planning and from planning to operation. Hence, it is urgent to develop an idea of low-carbon development so as to promote the movement of green campus with a digital management model under the principles of saving energy, land, water, materials, and environment (Wu and Zisong 2013).

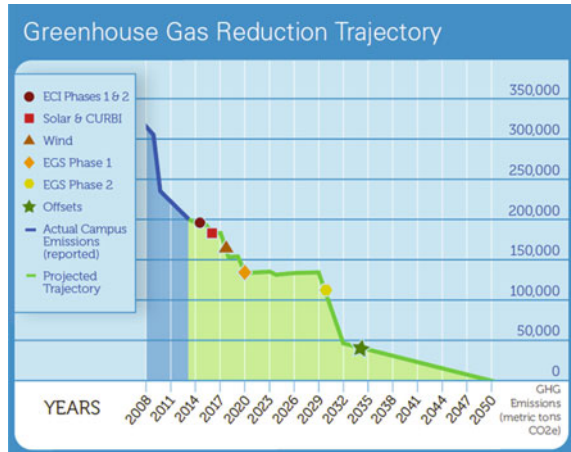
3.3 Inadequate Stamina for Construction

Since the operation and construction of green campuses is a time-consuming and huge project, every school should conduct a systematic and scientific theoretical study according to its characteristics of running before practicing. Nevertheless, inadequate knowledge on the importance of green campuses has directly resulted in a shortage of capital and necessary hardware and software facilities. As a result of that, there is a lack of continuity for developing green campuses when the work is done only by some staffs and part-time teachers with some public facilities.

4 “Climate Action Plan” by Cornell University

Under the framework of AUPCC, hundreds of college and university presidents in the United States committed to start it in colleges and universities and reduce the emission of greenhouse gases (Zhang and Zhang 2011). The content includes the

Fig. 1 Greenhouse gas reduction trajectory. *Source* Cornell climate action plan and roadmap (2014–2015)



determination of action plans and the objective of neutral carbon emission. In 2007, Cornell University made a “Climate Action Plan,” which regards carbon neutrality as a strategic direction for promoting core tasks of the school, such as teaching, scientific research, and community service. According to the plan, the emission of greenhouse gases is expected to decrease to zero in 2050 (Fig. 1).

4.1 Quantitative Emission Reduction Target and Stage Plans

Seven neutrality key actions are put forward: (1) complete phase 1 of the energy conservation initiative (ECI) and initiate phase 2 to conserve energy in campus buildings; (2) integrate building energy standards and energy modeling into the building design, review, and approval process in order to maximize energy efficiency; (3) optimize the campus heat distribution system to increase efficiency and cost-effectiveness and to facilitate the integration of Cornell’s future energy sources; (4) capitalize on more than 50 campus waste streams and other university-owned biomass resources to generate renewable energy through Cornell University Renewable Bioenergy Initiative (CURBI); (5) eliminate the combustion of fossil fuel for campus heating by developing an enhanced geothermal system (EGS) hybridized with biogas, prepare a preliminary design and phased implementation plan for a hybrid enhanced geothermal system, and build a demonstration project; (6) support the expansion of regional wind generation capacity and integrate wind power into Cornell’s renewable energy portfolio; and (7) implement broad-based, mission-linked carbon management strategies such as forest management, carbon capture and sequestration, and community projects to offset unavoidable university emissions. Every aspect is calculated in its effort to carbon emission quantitatively.

4.2 Reconstruction of Single Green Building

When practicing the “Climate Action Plan,” 96.8 % “green campuses” required new buildings to meet LEED or equal effect evaluation standards, 65.5 % proposed the proportion of renewable resources, and 81 % clarified the proportion of the using of clean energy meeting standard for green certificate and came up with countermeasures from various aspects, such as single-building energy, materials, and illumination (Gan et al. 2012).

The importance of reconstructing single green building lies in that it cannot only improve energy efficiency but also make use of renewable resources. In Cornell University, both new and reconstructed teaching and laboratory buildings are regarding attaining LEED certificate as an important goal of development.

4.3 Pilot Projects of Campus Energy Technologies and the Monitoring System

As with energy action, Cornell University has employed two certified energy managers and senior engineers for overall monitoring the supply–demand balance between hydraulic/thermal power plants (the supplier) and campus buildings (the demander) under the college energy management plan.

1. Application of renewable energy technologies

From a macroperspective, optimization of energy distribution system in the campus has significantly improved the efficiency and cost-effectiveness of energy using and facilitated the integration of new energy technologies of Cornell University in future. In the projects, the necessity to update or maintain short-term and long-term pipelines is analyzed and proven through collecting real indoor data so as to guarantee the necessity and feasibility for using new energy technologies for different buildings. Meanwhile, Cornell University is planning to use its existing more than 50 technologies (such as enhanced geothermal system, gas-supplying energy, wind energy, and carbon management strategy) for developing renewable biological energy sources and establishing relevant demonstration projects (Fig. 2).

2. Real-time campus energy monitoring system

To monitor energy data in a more effective and quantitative way, Cornell University has established a real-time campus energy consumption monitoring system (Cornell Energy Dashboard). With this system, the teachers and students of the school can get to know energy consumption of every building in the school through Internet (Fig. 3). Based on an induction system, Cornell Energy Dashboard is able to monitor heat supply, ventilation, air conditioning, refrigeration, illumination, fireproofing, smoke detectors, public facilities, and elevators and to record the data. The installation of a great deal of sensors has made

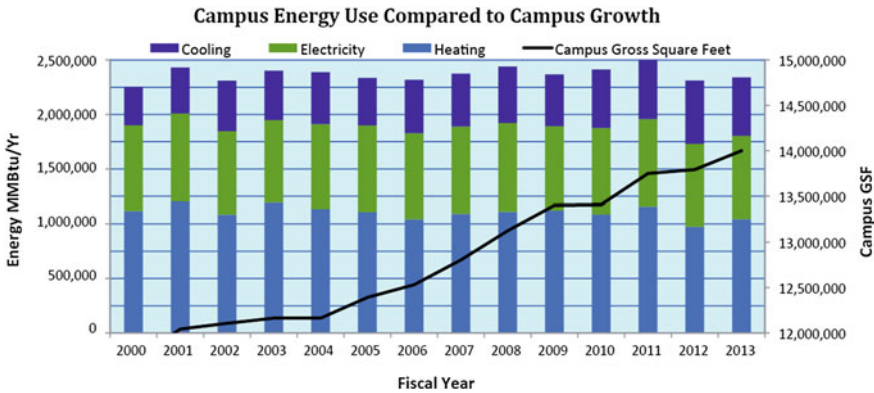
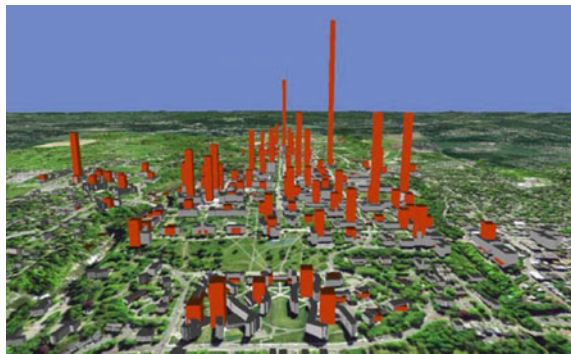


Fig. 2 Campus energy use compared to campus growth. *Source* Cornell climate action plan and roadmap (2014–2015)

Fig. 3 Cornell energy dashboard. *Source* building-dashboard.cornell.edu



sure the smooth operation of automatic control system, heat recovery system, and illumination system of Cornell University. Finally, the real-time campus energy monitoring system is used for planning all subsystems as a whole and integrating data.

4.4 Demonstration Effect as a Regional Low-Carbon Community

When constructing itself into a demonstration case of green campus, Cornell University has spread its influence and demonstrative technologies to surrounding communities. For example, its most famous “Energy Conservation Engagement Program,” “Climate Literacy Outreach,” and “STARS” have been applied in surrounding communities as mature experiences or demonstrative technologies.

The excellence of Cornell University in the field of public participation and its interdisciplinary cooperation have provided it with distinctive advantages on the issue of sustainable development. Since the issue of climate changes can only be solved by regional scales, the campus, as a pilot place for ecological and low-carbon technologies, can actually contribute its value only when its demonstration effect is spread to a wider regional network. In fact, many colleges and universities in the United States have come to realize the importance of regarding public/private sectors as their partners for speeding up the construction of green campuses; meanwhile, the colleges and universities are trying to practice in a bigger community by based on the campus.

4.5 Institutions for Guaranteeing Implementation of the Overall Plan

In order to facilitate the implementation of the pioneering plan of “Climate Action Plan,” Cornell University has established a new international management mode: establish a sustainable campus committee and employ “climate action plan” managers, special office staffs, and special administrative staffs for seeking for solutions to climate changes and how to promote construction of campus sustainability. As a matter of fact, all colleges and universities in the United States have established corresponding leading institutes in the process of starting and promoting green campus construction, such as Environment Committee, Green Campus Office, Environmental Working Group, Environmental and Social Institute, Comprehensive Waste Management Center, and environment-related connecting Web sites and organizations. These institutes are to formulate policies on campus environment in colleges and universities while organizing, directing, and guiding colleges and universities to construct green campuses (Han 2011).

5 Enlightenment for China’s Green Campus Construction

So far, China’s colleges and universities have made remarkable achievements in constructing “conservation-oriented campus” launched in 2006. Meanwhile, the energy conservation and emission reduction in campuses have been developed from the initial spread of idea to demonstrative practice of conservation-oriented campus to the current comprehensive green campuses with depth. However, as commented by ACUPP on “Climate Action Plan,” green campus is not a simple low-carbon plan but covers measurements on the setting of specific energy-saving goals, facilities of relevant scientific research projects, and determination of examination systems and future promotion. Therefore, green campuses in China are to be constructed and developed step by step, from points to areas and being innovated and improved constantly.

5.1 Formulate Scientific and Feasible Action Plans and Establish Management Institutes

From the experiences of the United States on constructing “green universities,” most green campuses have set goals and action plans by based on their characteristics, which has significantly contributed to their long-term and lasting success. Setting a strategic goal of becoming a green university is an ideal anticipation of colleges and universities about constructing green universities from a macroerspective. When setting goals, therefore, it is required to base on current status while coming up with the development objectives and action plans for constructing green universities by based on an analysis on current status of colleges and universities and making plans and implementation measures in different stages.

Furthermore, construction of green campuses is a complicated project, requiring a powerful core institute to manage in a unified way from the planning of campus environmental protection projects to promotion of green scientific research results to the society. In management level, it requires to establish a mechanism for promoting planning and coordination between government top design and multiple departments so as to strengthen the bottom-to-up (government leading) and top-to-down (self-initiated by schools) complementary development and perfect management mechanisms of all areas. For example, the “sustainability campus committee” founded by Cornell University and other institutes (such as “green committee” and “green office”) founded by other green campuses have played a critical role in management and provided abundant experiences for China with regard to construction and management of green campuses.

5.2 Demonstrative Application of Energy-Saving Technologies for Campus Single Building and Their Popularization and Promotion

The demonstrative value of green buildings never lies in the accumulation of advanced energy-saving technologies—but in the adaptable combination of them. Meanwhile, no matter whether it is newly constructed or reconstructed projects, consideration should be given to relationship between buildings and surrounding sites and natural landscapes as well as interaction with surrounding building groups.

In addition, tools for evaluating designs of green buildings should be put forward in the stage of popularization and promotion, including quantitative tools for evaluating costs of carbon emission in future and qualitative tools for society, environment, economy, institute priority, and other areas.

5.3 Energy Management of Campus Overall Planning and Energy-Saving Monitoring

Green campus is an important and strategic step from single green building to overall green communities and low-carbon cities. In the process of constructing a campus to reconstructing it, planners should actively implement environmental protection ideas such as saving energy, saving water, saving materials, and saving land while giving consideration to campus ecological network and energy network planning to create an ecological and effective campus environment (Zeng 2007). Moreover, guarantee circular flow of various types of physical energy in the campus ecological environment and exchange of all information through a network-type ecological structure so as to effectively bring all ecological factors of the campus ecological system into play.

From the Cornell Energy Dashboard, we can see that the project of constructing a campus energy-saving monitoring platform is a demonstrative project of colleges and universities. Purpose of the construction is to realize digitization of energy consumption, dynamic management, visual data, and indexation of energy saving. The practice of international college energy platform indicates that data of green campus should be collected step by step: collect energy consumption information of buildings in all campus areas to a transfer station and submit it to the energy source monitoring center. In fact, some schools (such as Tongji University) in China have developed systematic, real-time, and dynamic energy source monitoring platforms that are similar to “Cornell Energy Dashboard”; moreover, their platforms are featured with energy subindex measurement, which can provide beneficial guidance for energy saving.

5.4 The Campus Is Regarded as an Experimental Field of Regional Sustainable Development

Having integrated scientific research, education, planning, operation, citizen participation, and other fields, colleges and universities are playing as an experimental field of sustainable low-carbon development.

1. Promote green transformation of communities surrounding the campus by based on green campus

A college or university is a smart hub of a city, while middle schools and elementary schools are distributed among urban communities according to a fixed radius. The practice of regarding green campus as a practice base and displaying vivid examples will give impetus to students, parents, and community residents, therefore facilitating the green transformation of surrounding communities with half efforts (Fig. 4).

In the level of macroplanning, campus should correspond to the relationship between the development of nature, society, and historical culture of a city and

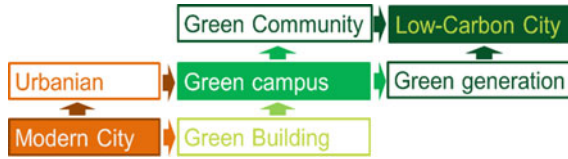


Fig. 4 Campus as the transitional scale between city and single building

integrated land use. Currently, newly constructed campuses of many colleges and universities have significantly driven the development of their surrounding areas. Furthermore, coordination between campus location and general urban planning goals is good for colleges and universities to rely on basic natural environment resources and social environment resources of the city; also, it is good for the city to achieve better development by relying on economic and social benefits from aggregation of colleges and universities. As with current campus reconstruction projects, however, studies should focus on means of using renewable resources and lowering energy consumption, as well as the interaction between the campus and surrounding communities.

2. Strengthen public participation and promote the interactive relationship among schools, enterprises, and society

Multiple-subject and multiple-level cooperation and communication among schools, enterprises, and society should be strengthened. In the United States, an integrated and rational interactive relationship among schools, enterprises, and society has been established in green colleges and universities. Colleges and universities should cooperate actively with the government and seek for policy and financial support from the government; also, they should cooperate with enterprises so as to know current market demands, transform the latest green scientific research results of colleges and universities into social productive forces, and better serve the development of enterprises and society. Contemporary colleges and universities should be viewed as part of the society, serving the society and being responsible for social environment. However, China's traditional education philosophy has separated schools from enterprises and society, which in fact is wasting educational resources. Therefore, the unified and interactive idea learning among schools, enterprises, and society in American green campuses is something worth learning and imitating by China for constructing green campuses.

6 Conclusion

From perspective of ecology and low-carbon emission, campus ecological structure is functioning as a connecting link between the proceeding [urban (suburb) ecological system] and the following (campus ecological nodes). Hence, considering

the three levels [building–community (campus)–city] of green campus planning from a general and systematic perspective is significant for both the campus and the whole urban ecological system.

It can be concluded from the experience of Cornell University on constructing green campus that green campus has become an experimental field and demonstrative area of low-carbon city construction. When creating a natural, comfortable, and safe space for teachers and students to study, live, and contact, green campus has realized sustainable development of colleges and universities. Meanwhile, it has promoted green transformation of communities around the campus and finally applied the results of green campus in a new round of developing and studying low-carbon cities.

References

- Cornell University (2013) Climate action plan update and roadmap 2014–2015, 2014
- Gan J, Hu Y, Wang M, Liu Z (2012) Enlightenment form green campus construction in U.S. In: Proceedings of the 8th international conference on green and energy-efficient building, vol 7
- Han Y (2011) Experience and enlightenment of the construction of “Green University” in the United States. *Univ Acad* 03:67–72, 66
- Tan H, Chen S, Zhang N (2012) Chinese green university report (6) 2011. CGUN, Shanghai
- Tan H (2013) Development and thoughts of China green campus. *Constr Sci Technol* 12:25–29
- Wu Z, Zisong W (2013) Introduction of green campus evaluation criteria. *Constr Sci Technol* 12:20–21, 24
- Zeng Q (2007) Ecological network construction on new campus planning. Huaqiao University, China
- Zhang J, Zhang Y (2011) Energy conservation actions and measures in American University Campus. *Meitan High Educ* 01:97–100