

Web-based Learning for Building Energy Efficiency – A Capacity Building Tool

Sam C. M. Hui

Department of Architecture, The University of Hong Kong
E-mail: cmhui@hku.hk

ABSTRACT

This paper discusses the needs of capacity building for energy efficient buildings in China and explains the potential of using the World Wide Web for improving the education and information programmes. A Web-based information system has been developed at The University of Hong Kong for the dissemination and promotion of energy efficient technologies. The Web materials from the system have also been used to create a learning environment for supporting university education and professional training and for promoting informal learning and self-study of the subject. It is believed that the Web-based approach can be promoted in China to enhance the capacity-building activities. Courses and training programmes are now being developed for promoting energy efficiency and sustainable architecture.

1. INTRODUCTION

With fast economic growth and increasing demand for higher living standard, China is facing a great challenge in building and energy development in the 21st century. Chinese cities are developing rapidly and many of them are already experiencing major environmental effects from fossil fuel-based energy consumption. The situation is getting more complicated when poorly constructed existing buildings are being fitted with air conditioners at rapid rates [Tu, 1996]. To achieve sustainable development, increased efficiency of energy use is very important. Although China has improved the level of energy efficiency in the past decade (mainly from the industrial sector), far greater improvements are critical to the economic and environmental future of the country [Sinton, Levine and Wang, 1998]. It is believed that China has made less progress in buildings than in other sectors and it is projected that future buildings in China will consume about one-third of the total primary energy. Therefore, there is an urgent need to promote and ensure building energy efficiency.

A major obstacle to the improvement in building energy efficiency is the lack of means to encourage widespread adoption of efficient measures. Proper knowledge of energy efficient buildings and their energy-saving investments is currently lacking in many levels of the society. Many building professionals lack formal training in the skills and disciplines needed to undertake work on renewable energy systems and energy management [Jennings and Lund, 2001]. Existing and emerging technologies for energy efficiency are not widely understood and integrated into the buildings. The dissemination and application of energy efficient technologies are often hindered by the lack of available and accessible information [Hui, 1999]. To help resolve these problems, a web-based information system has been developed at The University of Hong Kong to promote building energy efficiency and encourage active learning of the concepts and technologies. It is hoped that the work could strengthen the capacity for human resource development and enhance the awareness and penetration of the knowledge for energy efficient buildings.

2. THE NEEDS OF CAPACITY BUILDING

According to China's Agenda 21, capacity building is based on the interaction of national planning, decision-making, administration, the environment, resources, and scientific, technological and human resources [State Council of People's Republic of China, 1994]. In other countries, capacity building is being understood in many different ways. For some it is simply another word for training, but experience has shown that capacity building is really enablement and empowerment and that training, or, more broadly, human resource development, is only one of many tools to achieve it. The others, equally important, are developing a supportive legal, regulatory and institutional framework, strengthening organisations and building aware, competent and committed civil society. With the ongoing conversion of China's economic system from a centrally-planned to a market economy, the existing institutional framework for energy conservation must be transformed to operate more effectively in the new economic environment.

Capacity building for energy efficient buildings should focus on enhancing both technological and market-oriented capabilities. Education is a key factor here since the success of the policies depends very much on the people's understanding and awareness, adequate information for design and analysis, and sufficient manpower with technical and management skills [Hui and Cheung, 1999]. The education process, in broad sense, covers all levels of education including primary, secondary school education, technical and vocational training, university education, short courses and workshops, and continuing professional development. The objective is to effectively disseminate the information and provide appropriate training for developers, architects, engineers, technicians and building users as well as decision makers, businessmen and industrialists.

Information access is also critical for capacity building. Insufficient knowledge and experience about energy efficient technologies will affect decision-making for building design and operation. It is important to provide the necessary information, both to the decision-maker and to the public at large, in order to sensitise them on the potential of energy efficiency; and to provide professional know-how and expertise sharing with regard to energy efficient technologies. At present, the related information and technologies about energy efficiency are growing very fast and getting more and more complex. To handle and disseminate the information effectively, an efficient way of information management is needed. It is believed that the Internet technology can help to achieve the goals of capacity building more effectively.

3. MAKING USE OF THE WORLD WIDE WEB

The Internet has evolved very rapidly over the past few years. In particular, the rapid growth of the World Wide Web (WWW or Web) provides highly customised, accessible and interactive sources of information to a widely distributed user base. Because of its flexibility, timeliness and breadth of access, the Web can be an effective medium for the delivery of good quality education and training for energy efficiency topics [O'Mara and Jennings, 2001]. The availability of on-line information is becoming more and more attractive to people interested in energy policy and energy systems. Compared to traditional paper-based communication, the Web as a network infrastructure has the great advantages of flexibility, low cost and rich environment.

A Web-based approach has several distinct advantages over the traditional software production and distribution. First, given the sophistication of Web development tools, the user interface can be designed with considerably less efforts than with traditional methods. Second, the cost to distribute the product is minimal. Furthermore, future refinements or additions to the program do not require physical redistribution or reinstallation of the software or documentation. Once the material is established, updating annually or at regular intervals should not be expensive. Changes need only be made to the master version (located on the home server) for all users to have the benefit of these changes. Any user with a forms-enabled Web browser sees a seamless interface free of most hardware and software compatibility and installation problems. Regardless of the computing resources they

have locally available, users have access to powerful computational engines residing on the host server. Another advantage is that users of any Web browser can access the tool regardless of platform, and the Web provides immediate access to all the other relevant information that is constantly evolving on the Internet.

The compilation and dissemination of documents concerned with energy efficient buildings in electronic format provide substantial benefits for those who are able to access Internet. Government agencies, research institutes, professional associations and even individuals now have their own web page devoted to energy efficient and sustainable building, so news and information concerning energy efficient building, extensively reported in the Internet, represent a rich mine of information and starting points for designers and developers, as well as for the general public. The multimedia nature of the Web also provides a rich and interactive environment with new patterns of communication and interaction.

4. WEB-BASED INFORMATION SYSTEM

A Web-based information system has been developed at The University of Hong Kong for dissemination and promotion of energy efficient technologies [Hui, 1999]. The system aims to establish a rich information network for building energy efficiency to which people can have easy access and from which departments and agencies concerned can conveniently obtain the latest, most comprehensive information. By making the information more accessible to building designer, policy makers, researchers and others involved in the building life-cycle, it is possible to keep them motivated and encourage them to become more aware of the potential and benefits of energy efficiency. Figure 1 shows the major sections of the system as presented on its web site (<http://arch.hku.hk/research/BEER>). The system is made up of a group of modules containing information, data and hyperlinks for a set of important topics on energy efficiency in buildings. A library of case studies and lists of Internet resources are being developed at present.

(a) Climate analysis

The basic principles of building climatic design are explained and the climate information and data of Hong Kong are provided. Information about climatic design for locations in mainland China is now being developed. Links to data sources of other locations in the world are also provided.

(b) Energy simulation

The simulation methods for building energy analysis are introduced and the related simulation tools are explained. There is also a link to the DOE-2 Resources Centre (Hong Kong) established by collaboration with the Simulation Research Group of the Berkeley Laboratory in USA.

(c) Energy standards

Building energy standards, codes and guidelines in Hong Kong are described. Online versions of the codes and guidelines are provided. Other related activities to energy efficiency are listed and explained. Information about the building energy efficiency standards in mainland China and other worldwide locations is provided.

(d) Renewable energy

Basic concepts of renewable energy are described and the Internet resources for renewable energy are provided.

(e) Sustainable architecture

Basic principles and concepts of sustainable architecture are discussed. A comprehensive list of the design guides and references is provided. Related web links are presented.



建築節能研究 B uilding E nergy E fficiency R esearch  		[Integrated Building Technology]		香港大學建築學系 HKU Architecture
		Overview		About BEER
	氣象分析	Climate Analysis Conduct <u>analysis of building climatic data (ABCD)</u> to provide critical information for energy efficient design in Hong Kong and mainland China	能效模擬	Energy Simulation Develop skills in <u>building energy simulation tools (BEST)</u> for studying and evaluating design options and performance [also <u>DOE-2 Resource Centre (Hong Kong)</u>]
	節能標準	Energy Standards Investigate <u>building energy standards and codes (BESC)</u> in Hong Kong, mainland China and other places for improving energy policy and strategy	網上學習	Web-based Learning Provide flexible and effective <u>learning environment for energy efficiency in buildings</u> (suitable for architects, engineers, other professionals, and general public)
	可再生能源	Renewable Energy Promote <u>renewable energy (RE)</u> to ensure clean and environment-friendly energy sources	可持續建築	Sustainable Architecture Study <u>sustainable architecture and building design (SABD)</u> to integrate energy efficiency into sustainability concern
	Internet Resources Collect and select useful resources for related issues including: <u>Architecture, Building Energy Efficiency, Building Services, Search Engines</u>		Case Studies Develop a <u>library of case studies</u> for energy efficient and sustainable buildings	

Figure 1. Building energy efficiency research (BEER) web site (<http://arch.hku.hk/research/BEER>)

5. LEARNING ENVIRONMENT

An important function of the system is to support education and training activities. At present, several instructional modules have been developed for learning about energy efficient and sustainable buildings. The modules have been used in the architectural courses in the Department of Architecture of The University of Hong Kong to augment the usual courseware and support the design studios [Hui and Cheung, 1999]. The Web materials have also been used to support training workshops for practicing building professionals. An outline of a training workshop held in August 1999 in Hong Kong is shown in Table 1 (this workshop has total six hours conducted in two evenings).

Table 1. Outline of a training workshop on energy efficiency in buildings

1. Basic Principles 1.1 Climate and Site 1.2 Building Envelope 1.3 Building Systems	3. Energy Efficient Technologies 3.1 Passive Cooling and Daylighting 3.2 HVAC Systems 3.3 Active Solar and Photovoltaics
2. Building Energy Efficiency Standards 2.1 Basic Concepts 2.2 Building Energy Codes 2.3 Building Energy Performance	4. Building Energy Analysis Methods 4.1 Building Energy Simulation 4.2 Building Energy Audits/Surveys 4.3 Exercises

It is interesting to note that “informal learning” through browsing is quite common for energy-related professionals but the great majority of information made available on the Web is not specifically prepared for learning purposes. Formal instructional systems, which are rather didactic, will guide the learner to the achievement of very specific learning outcomes. On the other hand, there

are forms of instruction that create a context for guided exploration for autonomous learners. Since instructional means are often weak or not present in a typical web context, greater cognitive demands are put on the user-learner to make the best use possible of the information resources available. To better utilise the Web resources for capacity building, it is necessary to consider how informal learning can be made use of for educational purposes.

The use of Web-based system will encourage self-paced and distance learning. In recent years, the Web resources on energy efficiency around the world have grown very fast and this provided more opportunities for self-study through informal learning. However, because of the largely unregulated nature of the Internet, there is much dross as well as good information on the Web. Keeping track of all the relevant links is also not easy since documents on the Web are ephemeral and dynamic. Connection speed, quality, reliability and cultural differences are still common barriers to the effective use of web-based information for learning. Designing a learning environment for a wide range of audience on the Web requires careful study of the pedagogy and practical issues.

6. PROSPECTS

China is the world's most populous country and will become one of the world's largest Internet markets in the coming future. According to the July 2000 survey report of the China Internet Network Information Center [CNNIC, 2000], there are over 16.9 million Internet Users in China and the number is accelerating at a rapid rate every year. Although the connection speed, availability of Internet access and limitation of international bandwidth are still common barriers to the Internet users, Web development and online education are believed to have good potential in China [Qiu, 2000]. If Web-based information and learning can be promoted in China, the capacity building for energy efficient buildings can be carried out more effectively.

The long-term objective of our research and teaching development in The University of Hong Kong is to establish a sound foundation for supporting energy efficiency and sustainable architecture. Courses and training programmes are now being developed in our University to enhance teaching quality and improve learning opportunities for these subjects. Continuing education and professional development programmes will be developed to enable practicing professionals to constantly upgrade their knowledge and to improve their skills. We are also discussing and developing co-operation with the relevant institutions in mainland China and in the world to share experience and knowledge.

7. CONCLUSION

The success of energy efficiency in general and energy efficiency in buildings in particular is very much dependent not only on overcoming professional barriers but also on sharing information. To improve the capacity-building activities in China, it is important to promote and harmonise co-operation in education, training and research as well as in the transfer of research findings to industry at the provincial, national and international levels. The Internet is now a critical tool for energy professionals; the Web creates unimagined opportunities for access to information and knowledge and new ways for individuals, communities and governments to learn and to work together. As energy efficient building is evolving rapidly as an advanced academic field so that the content of a textbook tends to get outdated quickly, the Internet will play an increasingly important role for supporting the education and training in this field.

ACKNOWLEDGEMENTS

This work was supported from the CRCG Research Grants of The University of Hong Kong.

REFERENCES

- CNNIC, 2000. *Semi-annual Survey Report On Internet Development In China (2000.7)*, China Internet Network Information Center (CNNIC), <http://www.chineselocal.com/cnnic.htm>.
- Hui, S. C. M., 1999. Web-based information system for energy efficient technologies in HVAC and the built environment, In *Proc. of the 1999 Asia-Pacific Conference on the Built Environment*, 29 November – 2 December 1999, Taipei, Taiwan, pp. A7.1-A7.9.
- Hui, S. C. M. and Cheung, K. P., 1999. Developing a web-based learning environment for building energy efficiency and solar design in Hong Kong, *Solar Energy*, 67 (1-3): 151-159.
- Jennings, P. and Lund, C., 2001. Renewable energy education for sustainable development, *Renewable Energy*, 22 (1-3): 113-118.
- O' Mara, K. L. and Jennings, P. J., 2001. Innovative renewable energy education using the World Wide Web, *Renewable Energy*, 22 (1-3): 135-141.
- Qiu, H. S., 2000. *Internet in China*, TeachOnNet.com Limited, Hong Kong. (in Chinese: 丘海雄, 2000。《中國互聯網 -- 市場分析及發展狀況調查報告》, TeachOnNet.com Limited, 香港。)
- Sinton, J. E., Levine, M. D. and Wang, Q. Y., 1998. Energy efficiency in China: accomplishments and challenges, *Energy Policy*, 26 (11): 813-829.
- State Council of People's Republic of China, 1994. *China's Agenda 21: White Paper on China's Population, Environment, and Development in the 21st Century*, Chapter 6 – Education and Capacity Building for Sustainable Development, China Environmental Science Press, Beijing. (also available at <http://www.acca21.edu.cn/>)
- Tu, F. Q. (ed.), 1996. *Techniques on Energy Efficiency in Buildings*, China Planning Publisher, Beijing. (in Chinese: 涂逢祥, 1996。《建築節能技術》, 中國計劃出版社, 北京。)