



Technical Note

Sustainability in architectural education: A comparison of Iran and Australia

Mohammad Taleghani^{a,*}, Hamid Reza Ansari^b, Philip Jennings^c^a Faculty of Architecture, Delft University of Technology, Delft, The Netherlands^b Faculty of Architecture, University of Tehran, Iran^c School of Engineering and Energy, Murdoch University, Australia

ARTICLE INFO

Article history:

Received 4 June 2009

Accepted 11 November 2010

Available online 28 January 2011

Keywords:

Renewable energy

Architectural education

Sustainable architecture

Iran

Australia

ABSTRACT

Over the past decade, several new approaches have emerged to renewable energy education that seek to address the needs of the 21st century for sustainable energy supply systems. In addition, unlike conventional architectural education which does not cover renewable energy issues in its curriculum, these days, renewable energy education has an identity of its own within the discipline of architecture. This paper will clarify academic obstacles that are impeding the development of sustainable architectural education. These obstacles include: ambiguous definitions of sustainable architecture, confusion over the meaning of sustainability, and lack of experts in this field.

In the last part of this paper we compare academic architectural education in the field of renewable energy in two countries, Iran as a developing country in Asia and Australia as a developed country in Oceania. Lessons can be drawn from these case studies in regard to the obstacles and progress in the development of sustainable architecture education.

© 2010 Published by Elsevier Ltd.

1. Context

Architecture is a unique human activity that blends artistic creation with scientific knowledge and technological innovation. Architecture plays a major role in providing for basic human needs for shelter, transport and commerce. Architecture has both aesthetic and utilitarian objectives and it also has a vital role to play in the quest for sustainability of human civilization. The challenge for modern architects is to incorporate the principles of sustainability into their designs, without compromising their utility or style. This will require a fundamental reorientation of architectural education to emphasize the conservation of energy and natural resources in new and existing buildings and facilities.

2. The role of renewable energy education in architecture

Education is a powerful agent of social change, it raises awareness of new developments, it provides training for the professionals and it trains researchers who will develop the next generation of systems and devices. In addition community education creates confidence in the new products and trains the public to use them effectively. Education also has a crucial role in the development of

the renewable energy industry [1]. It is not the only ingredient needed for success, but it performs several vital functions including:

- Promotion of greater public awareness of the technology;
- Development of consumer confidence in the technology;
- Training of technical support staff, which are essential for designing, installing and maintaining high quality renewable energy systems;
- Initial training of engineers, scientists and researchers who will develop new systems, devices and technologies for the industry;
- Training of policy analysts who are knowledgeable about the industry and are able to produce effective policies for industry development; and
- Training of people who will provide advice and assistance to future customers of the industry.

Experience shows that those firms that have given adequate attention to these issues have thrived in the highly competitive, high technology market place, while many of those that have ignored the need to invest in information and education have often failed in spite of having good products for sale [2].

Some professional associations support and determine a charter for architectural education which is aligned with sustainability principles. As an illustration, UIA (International Union of Architects) proposed architectural education with these characteristics:

* Corresponding author. Julianalaan 134, 2628 BL Delft, the Netherlands. Tel.: +31 6 19957368.

E-mail address: m.taleghani@tudelft.nl (M. Taleghani).

"Architecture is one of the key professions involved in shaping the built environment and urban space. Architectural education that prepares architects for a professional life should therefore, be seen, at least in the following contexts and the specific objectives pertaining to them:

- Social, cultural, political contexts
- Professional, technological, industrial contexts
- The World: local, global, ecological contexts
- Academic contexts including science and knowledge in general" [3]

Clearly UIA considers sustainable approaches within this plan. Words such as technological and global ecological context convey the impression that sustainable architecture and renewable energies are important components of architectural education.

3. The current status of renewable energy education

Over the past two decades, several new approaches have emerged to renewable energy education in many academic majors like architecture that seek to address the needs of the 21st century for sustainable energy supply systems [4]. Although there is a general consensus on the importance of sustainable architecture education, some questions are not answered yet. As an illustration, what courses are essential for a student of architecture? Likewise, in which courses can a student of architecture gain an understanding of sustainability and environmental issues?

In addition, unlike conventional architectural education, which did not include renewable energy issues in its curriculum, these days, renewable energy education has an identity of its own in the discipline of architecture, with special techniques, standards and requirements which are not normally encountered in other disciplines. In a recent paper, we have reviewed the availability of courses in renewable energy and architecture in developed and developing countries [5]. In this paper, we present a detailed comparison of the current status of sustainable architecture education in two countries, one of which is a developing nation and the other a developed industrial nation.

4. Obstacles to academic education in renewable energy

Stasinopoulos [5] outlines some academic obstacles to sustainable architecture teaching and it seems that renewable energy education has been affected by these problems, also. They briefly are:

Fringe reputation: In most schools that show environmental concern, related issues are usually offered in elective classes, detached from design studios. This creates a 'fringe' reputation for sustainability, separating its principles from the main design projects to the periphery of architectural learning. As a result, no practical experience is gained in how to introduce sustainable qualities into the 'core' design agenda.

Number crunching: In many cases the emphasis is on quantitative rather than qualitative matters. As a result number crunching eclipses design, and students tend to associate sustainable concerns with numerical performance only, detached from issues like comfort, resources, or societal ethics. In that manner, sustainability-related courses are considered similar to those on technical fields like structural or mechanical design, but not 'real' architecture.

The Beaux Arts tradition: Design projects are frequently detached from earthly reality as if they refer to a space station, hardly interrelated with nature or society. Societal ethics or environmental awareness are not embedded in the agenda, confining training to merely technical skills with major focus on the aesthetic. "An architectural student suddenly transported to many of our architecture schools from 1900 Paris would feel right at home" [6].

Lack of support: Furthermore, there is insufficient supplementary input through technical classes that could support sustainable design projects. When students do not understand the dynamic linkage between structures, environmental conditions and users, it is not easy to differentiate, say, between "building in the landscape" and "building in interaction with the landscape" [7].

Although the above reasons are some of most important obstacles to renewable energy education, some other reasons often occur in different countries and cultures. These include:

National resources: Renewable energy is usually taught in developed countries that have a shortage of fossil fuels, such as oil, natural gas and coal. Therefore, in oil rich countries that do not need renewable energies for their supply, this kind of education usually is neglected.

Social issues: There are some important events that play a key role in academic education. As an illustration, war, natural disasters (like earthquakes) and governmental policies determine some directions in education.

Lack of experts: Renewable energy education suffers from a lack of experts who are skilled in this field in many developing countries such as Iran. On the other hand, if there is no teacher, there will be no student.

5. Case studies

It has been 15 years since UIA (International Union of Architecture) released the "Declaration of Interdependence for a Sustainable Future" suggesting that the architectural profession should seek "to achieve ecologic and energetic sustainability within the limited time that is likely to be available" [3]. From this point of view, the role of architecture (building construction) in energy consumption demonstrates that all countries should make a fundamental decision to integrate renewable energy education into their architectural education. In this paper, academic efforts of two countries in the field of energy education will be examined: the former, Australia as a developed country and the latter, Iran as a developing country. Murdoch University in Australia and the University of Tehran in Iran both offer energy studies in their professional architectural education programs.

These institutions were chosen for this study because they have well established and highly respected offerings in renewable energy and architecture and the authors believe that the issues and challenges they face are relevant to other institutions that are intending to offer courses in sustainable architecture.

5.1. Iran

5.1.1. Energy consumption in Iran

Iran is a member of the Organization of Petroleum Exporting Countries (OPEC), and ranks amongst the world's top three holders of proven oil and natural gas reserves. Iran is OPEC's second-largest exporter after Saudi Arabia, and is the fourth-largest exporter of crude oil globally after Saudi Arabia, Russia, and Norway. Natural gas accounts for half of Iran's total domestic energy consumption, while the remaining half is predominately oil consumption. The continued exploration and production of the offshore South Pars natural gas field in the Persian Gulf is a key part of Iran's energy sector development plan [8].

Although Iran has many natural resources such as gas and oil, alarms about global and national energy consumption led decision makers to take action against all kinds of energy wastage. As an illustration, because building construction consumes about 50% of all energy in Iran, the Ministry of Energy and the Ministry of Housing and Urbanisation formed the Iran Fuel Conservation Company to be a vehicle for the study of energy efficiency in the

field of building construction in Iran. In addition, cited organizations have prepared a national handbook in energy consumption for building construction in Iran.

5.1.2. Renewable energy education in Iran

Energy issues are considered in two majors of academic education in Iran: Energy Engineering and Architecture. The former, involves correlation of energy and craft (in BSc degree), and the latter covers technical energy issues in building construction, design and architecture (from BSc to Master degree). In addition, there are two universities that offer major of Energy in Architecture and we will consider the University of Tehran as a representative in the next section.

5.1.3. Renewable energy education at the University of Tehran

Iranian bachelor's degrees in architectural education include one special course about energy issues, namely "Environmental Engineering". However, in the Masters degree, a professional major is offered in the University of Tehran which is called "Energy in Architecture". This major was founded in 2005 and the curriculum of this department involves the courses listed in Table 1.

In addition, this department cooperates with the Ministry of Energy and the Iran Fuel Conservation Company. These two organizations are policy makers in the field of renewable energy in Iran. This Department is going to become a faculty in the near future and intends to offer four majors in the graduate degree in its field in the next 10 years. The majors are as follow with their year of commencement:

- a) Low energy Architecture (2010),
- b) Energy Systems Management (2014),
- c) Heating, Cooling and Lighting Systems (2012),
- d) Environmental Design Sustainability (2016).

5.2. Australia

5.2.1. Energy consumption in Australia

Australia is the world's largest coal exporter and is the fifth largest exporter of liquefied natural gas (LNG). This country is rich in natural resources with significant petroleum and coal reserves. Australia's energy consumption is dominated by coal, which fuels most of the country's power generation. Petroleum accounts for a large share of energy consumption, but due to declining domestic production, Australia is facing a growing dependence on petroleum imports. Over the past two decades, Australia has steadily consumed increasing amounts of natural gas and oil, which is likely to continue over the medium term [9].

Table 1

Curriculum of master degree of "Energy in Architecture" in University of Tehran.

First semester	Energy Management in Architecture and Urbanisation Earth Conditions Control Computer in Architecture Seminar
Second semester	Climate and Vernacular Architecture Details of Active & Passive Solar Systems Research Methods Architectural Design & Energy (1)
Third semester	Ecological Design Basis Physics of Buildings (Daylight, Air Circulation,...) Architectural Design & Energy (2)
Fourth semester	Urban Design & Energy Building Construction Steps Planning & Design Methods Final Thesis

5.2.2. Renewable energy education in Australia

The courses available include undergraduate and postgraduate programs which are offered on a coursework or research basis on various aspects of renewable energy. This includes courses in renewable energy technology, energy efficiency, energy management and energy policy and planning. The detailed, tabulated results of this survey have been published elsewhere [10].

5.2.2.1. Undergraduate courses. Australia has 40 Universities. Only three Australian Universities (Australian National University, University of New South Wales and Murdoch University) offer full undergraduate degree programs in renewable energy engineering or energy studies. Most Universities offer one or two courses on renewable energy as part of their science or engineering degree programs. Some Universities embed this material in other programs relating to electrical and power engineering. All of the undergraduate programs have been developed since 2000 in response to market demand for skilled professionals specialising in renewable energy and/or energy efficiency.

5.2.2.2. Postgraduate courses. Six Australian Universities offer full coursework degree programs at the postgraduate level in renewable energy and energy management. These are Curtin University, Monash University, Murdoch University, RMIT University, Melbourne University, and University of NSW. The offerings by the Universities are designed for experienced professional scientists and engineers who may wish to change career direction and move into areas such as renewable energy systems, energy policy and planning, energy efficiency or energy management. A variety of programs are available (23 in all) including postgraduate certificates (1 semester), postgraduate diplomas (2 semesters) and Masters by coursework (2-4 semesters).

Murdoch University offers coursework in renewable energy to external students via the internet. This enables it to provide courses to students located anywhere in the world provided they have internet access. Murdoch University also offers Australia's only Masters program in Environmental Architecture, in conjunction with its program in renewable energy.

5.2.2.3. Postgraduate research programs. Postgraduate research programs in renewable energy and energy management are offered by eight Australian Universities (all of the above plus Newcastle and Tasmania Universities). Australian Universities have particular strengths in photovoltaics, passive solar design, energy efficiency and solar thermal systems. Very few Universities offer research opportunities in energy policy or energy economics although this is an area of great interest to government and industry.

Renewable energy education is still not a mainstream activity in most Australian Universities and the training opportunities are particularly limited in some parts of the country. The coverage of the technologies and the issues is also rather patchy. This situation appears to be replicated internationally [11] (Table 2).

5.2.3. Renewable energy education in Murdoch University

5.2.3.1. Energy studies. Murdoch University began offering a postgraduate diploma in energy studies in 1992. This was aimed at graduates who wished to shift their career path into renewable energy technology, energy efficiency or policy. The postgraduate diploma in energy studies was developed for both on-campus and external study to cater for the needs of busy professionals who could not attend classes during work hours.

Energy Studies is a new interdisciplinary area which aims to train professionals to work in technology or policy areas. It equips them with skills in technology, engineering, economics, management and environmental science to enable them to plan, design,

Table 2
Degree programs in renewable energy or sustainable architecture in Australian universities.

Universities	Degree Programs in Renewable Energy or Sustainable Architecture
Australian National University	BE in Sustainable Energy Systems
Curtin University of Technology	ME in Renewable Energy Engineering
Monash University	Postgraduate Certificate in Photovoltaic Engineering Graduate Diploma in Energy Studies Postgraduate Diploma in Energy Studies MSc in Energy Studies MApp Sci in Renewable Energy MEngSci in Renewable Energy
University of Melbourne	BE in Photovoltaics and Solar Energy Graduate Certificate in Photovoltaic Engineering Graduate Diploma in Photovoltaic Engineering MEngSci in Photovoltaics and Solar Energy
University of New South Wales	Graduate Certificate in Sustainable Energy Graduate Diploma in Sustainable Energy ME in Sustainable Energy BSc in Sustainable Energy Management BE in Renewable Energy Engineering Postgraduate Certificate in Energy Studies Postgraduate Diploma in Energy Studies MSc in Renewable Energy MSc in Environmental Architecture
RMIT University	
Murdoch University	

evaluate or research energy supply and use issues in the context of ecologically sustainable development. Further details of the course structure and outcomes are provided elsewhere.

In the late nineties the Postgraduate Diploma in Energy Studies and Master of Science in Renewable Energy were made fully available on-line and no on-campus attendance was required. The on-line option is extremely popular with both external and on-campus students and regular surveys of the students have shown high levels of satisfaction with the on-line delivery. Many of the graduates of these programs have been successful in changing their career paths and have obtained interesting new jobs in the renewable energy industry or in public service agencies concerned with energy or greenhouse policy [12].

In 2002 a new undergraduate BSc program in Sustainable Energy Management was introduced at Murdoch University and this has also proven popular, particularly in combination with physics, renewable energy engineering and sustainable development.

5.2.3.2. Environmental Architecture. In response to requests from graduate architects for an advanced course covering the principles of energy efficient buildings and passive solar design, Murdoch University introduced a Masters by coursework in Environmental Architecture in 2006. This program is closely related to other programs in renewable energy and sustainable development, also offered by Murdoch University. It is initially being offered for on-campus study only, but once it is fully developed it will be offered on-line to the international market. Further details are available in the paper by Baverstock and Parker [13]. The initial enrolments from practicing architects have been less than expected, due mainly to a lack of demand from governments and clients for sustainable designs.

5.3. Comparison

In order to compare the renewable energy education in these two countries (Iran and Australia) we will summarize the similarities and differences in their approaches to renewable energy in Table 3. There are several similarities and differences:

Table 3
Renewable energy education comparison between Iran and Australia.

	Iran	Australia
Degree	BS, MS	BSc, MSc, MPhil, PhD
Universities	2	8
Kind of offering	On-campus	On-campus and On-line
Renewable Energy majors related to Architecture	Energy Eng, Energy in Architecture, Low energy Architecture (2010), Energy Systems Management (2014), Heating, Cooling and Light Systems (2012), Environmental Design Sustainability (2016).	Energy Studies, Sustainable Energy Systems, RE Eng, PV Eng, Sustainable Energy Management – PV and Solar Energy

5.3.1. Similarities

- Commencement of attention to renewable energy in the field of architecture over the last four years (Iran 2005, Australia 2006).
- A strong relationship between the academic issues and the concerns of industry. This relationship encourages RE to be supported by governments.

5.3.2. Differences

- Lack of variety in courses on RE education in Iran (Iran has 2 majors currently, however Australia has 6).
- Broader focus in Australian courses, not only technical issues, but also social, environmental and policy aspects.

Above points led us to some conclusions in regard to RE education that will be discussed in Section 6.

6. Conclusions

The importance of sustainable architecture for developing nations is recognised. This is a clean development option and there is an urgent need to transfer knowledge to all countries to promote improvements in building design and operation. This paper addresses some pioneering efforts in this field and is intended to promote further debate about this important topic.

In order to achieve this goal of incorporating the principles of sustainability into architecture education, the paper offers five suggestions:

- To educate and train more policy analysts and managers on issues related to energy by introducing new courses such as Energy Economics and Energy Policy to cover fundamental issues in energy decision making in all countries. Engineers and architects should also be exposed to these courses.
- To establish and develop renewable energy courses related to architecture and other engineering fields of study (such as building service engineering) to ensure that all future architects and engineers are aware of the potential of RE in their professions. At present only a few such courses are available.
- To offer renewable energy courses in first degrees (such as BSc and BE or even in high school) to inspire young students to enter this field. This will help to address the critical shortage of trained professionals in this field.
- To provide opportunities for continuing professional education of engineers and architects in the principles of sustainability and renewable energy. This can be done through postgraduate courses such as PhDs and Masters by coursework.

- Institutions should be encouraged to collaborate and share courseware in order to address the urgent need for courseware on sustainable architecture. There is a role here for professional organizations and governments, which can facilitate this process through intergovernmental agreements, staff exchanges and student scholarships.

References

- [1] Philip Jennings. Renewable energy education: an essential foundation for market development. In: Proceedings of the 35th ANZSES conference, Canberra, Australia; 1997. p. 1–5.
- [2] Jennings Philip. New directions in renewable energy education. *Renewable Energy* 2009;34:435–9.
- [3] UIA and architectural education reflections and recommendations. Berlin, Germany: General Assembly; 2008.
- [4] Kim Jong-Jin. Introduction to sustainable architecture. Michigan. USA: National Pollution Prevention Centre for Higher Education; 1998.
- [5] Thanos N. Stasinopoulos. Sustainable architecture teaching in non-sustainable societies. In: The 22nd Conference on Passive and Low Energy Architecture, Beirut, Lebanon; 2005.
- [6] Tony Brown. Education for sustainability: an operational model for sustainable design. In: Second Nature conference, "How Can the architect contribute to a sustainable world", Racine, Wisconsin; 2001.
- [7] Report of the UK Sustainability Special Interest group on behalf of the Centre for Education in the Built Environment, <http://www.cebe.heacademy.ac.uk/learning/sig/pdfs/report.pdf>; 2003.
- [8] <http://www.eia.doe.gov/emeu/cabs/Iran/Background.html>.
- [9] <http://www.eia.doe.gov/emeu/cabs/Australia/Background.html>.
- [10] Thomas C, Jennings P, Lloyd B. Renewable energy courses in Australian and New Zealand Universities. *Solar Progress* 2008;29(1):1–6.
- [11] Thomas C, Jennings P, Lloyd B. Issues in renewable energy education. *Australian Journal of Environmental Education* 2008;24:67–74.
- [12] Jennings P, Lund C. Renewable energy education for sustainable development. *Renewable Energy* 2001;22:113–8.
- [13] Baverstock G, Parker I. The Master of Science in environmental architecture: an appropriate response to reducing greenhouse gases, renewable energy for sustainable development in the Asia Pacific region. *The American Institute of Physics*; 2007:20–4.