

New Approaches to Renewable Energy Education

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Abstract

The rapid expansion of the renewable energy industry is producing a huge demand for well-trained professional people to design, install and maintain new systems. There is also a substantial need for policy analysts, researchers and teachers with experience in renewables. Many professional people are now seeking to move their career paths into the renewable energy field and they require advanced, on-the-job training. It is no longer sufficient to add a few topics or units on renewables to a conventional science or engineering course. Renewable energy education is emerging as a new discipline in its own right, with its own interdisciplinary curriculum that meets the criteria for sustainable development. Educating the community is also vital for creating a greater awareness of, and confidence in, renewable energy systems, and for training people to use them properly.

This paper describes some new approaches to renewable energy education that seek to meet the needs of industry and society for high-quality, environmentally friendly and socially responsible energy supply systems.

1. Introduction

Energy is an essential commodity in modern industrial society. It powers our homes, workplaces, transport and communications systems. It is an issue that affects everyone, yet one which is often neglected, until an energy crisis arrives. We are now living in the midst of an energy crisis that will not simply go away. There is unprecedented concern about fuel prices and the causes of price escalation and their effect on our quality of life. There is also a high level international debate under way about global warming and its relationship to energy use.

Many people are concerned about these problems and wish to address the symptoms as a matter of urgency, but few understand the basic causes of the problems. Consequently we fail to realise that fundamental social and technological changes are required to overcome them. Our education system has failed to give us a basic understanding of energy supply and use and their impact on society and the environment. As a result our leaders are searching for quick fixes although a deeper analysis would indicate that fundamental changes in lifestyle and attitudes are required. Such changes must be based on education but before the education system can assist it needs to be reformed and redirected.

Conventional energy systems have been extremely successful in providing reliable power supply for modern industry. Many excellent courses have been developed to train engineers and technicians to design, install and maintain these conventional energy systems. However, these systems are now the subject of controversy over issues such as global warming, energy security, public health, air pollution, waste disposal and ecological damage.

As a result of these concerns many nations are attempting to replace conventional power stations with renewable energy systems. The international community has taken the first steps towards cutting greenhouse gas emissions and the UN Commission on Environment and Development is urging all nations to adopt processes of ecologically sustainable development (WCED, 1987; UNCED, 1992).

Some areas of renewable energy are experiencing rapid growth in demand as a result of these agreements and this is leading to a larger scale of production and falling prices for new systems. Simultaneously the prices of some fossil fuels are escalating and this is creating an attractive market for renewables.

However the surge of interest in renewables over the past five years has caught us unprepared. Few expected such a rapid increase in demand and few had been planning to develop the capacity to train the professional people needed to launch the industry into this new phase.

A serious shortage of skilled professionals, with experience in renewables, is already apparent. The types of personnel in demand include designers, installers, service and sales persons, policy analysts, scientists, engineers, teachers and researchers. Unless we can train them quickly the quality of systems may be compromised and demand for renewables may be adversely affected as a result (Jennings and Lund, 2000).

To illustrate this problem, a recent survey of users of hybrid RAPS systems in Australia found that only two thirds of them were in working order at the time of the visit. Many users expressed disappointment with the product and many said that better education and training of the users and installers was essential (Lloyd *et al*, 2000). Poor quality systems and unrealistic expectations of users can give renewable energy systems a bad reputation and lead to market rejection of the product. This is an issue that education can effectively help to address.

Now that it is clear that a fundamental shift in energy markets is under way, a major effort is developing to train the new professionals needed to introduce the new technologies. These people are not the electrical engineers of yesterday, with a slightly different training. They are a new breed that understands the new technologies and the appropriate roles for them in the society of the future. They require a broader training in social, economic and environmental issues than was given to the current professionals who design and operate today's conventional power supply systems (Jennings, 1997).

2. The Role of Education in the Renewable Energy Industry

Education has a vital role to play in the development of a sustainable society. It is a powerful agent of social change, it raises awareness of new developments, it provides training for the practitioners and it trains researchers who will develop the next generation of systems and devices.

Community education creates confidence in the new products and trains the public to use them effectively. The need for education of the community and the vital role it plays in market development and in building confidence in renewable energy has often been neglected by most sections of the renewable energy industry. Education however, plays a central role in the development of new high technology industries as the examples of the computer industry and the aircraft industry clearly illustrate.

Education also has a crucial role in the development of the renewable energy industry (Jennings, 1997). 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, who 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
- 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 information and education have failed in spite of having a good product.

3. The Educational Needs of the Industry and Society

As a result of our surveys and enquiries we have identified the following needs of industry and the public for renewable energy education.

- retraining of professionals who wish to move into the renewable energy industry
- retraining of technicians and tradespeople who wish to work in this field
- training of scientists and engineers to design and develop new systems
- training in renewable energy technology and policy for financiers, investors and policy analysts
- short, in-service, professional development courses on aspects of renewable energy technology and policy for continuing professional education
- lessons and resources for schools
- contemporary information about renewable energy technology for the general public

Such training should not be confined to technology or policy issues alone. Because of the context in which the renewable energy industry is developing, it is essential that training should address economic, social and environmental issues arising from the technology as well. Renewable energy systems are expected to provide sustainable solutions to energy supply requirements. Therefore it is essential that designers of such systems are fully aware of the philosophy and practice of ecologically sustainable development (Jennings and Lund, 1999; IUCN, 1991; Miller, 1980).

4. New Approaches

Over the past five years there have been some innovative developments in renewable energy education that attempt to address the needs of industry and the public aspirations for sustainability and greenhouse gas abatement. There have been a number of important renewable energy education initiatives in Australia in recent years some of which are internationally significant. I will not attempt to review this entire field but I will focus on several key examples of new approaches to renewable energy education.

4.1. Technical Education

The Brisbane Institute of TAFE has offered a Certificate IV in Renewable Energy for more than a decade. Trevor Berrill and colleagues at BIT have produced learning packages to support this course. The Solar Energy Industry Association (SEIA) supports this course as the preferred pathway to accredit industry system designers and installers. These materials are used in a number of TAFE

colleges across Australia. As the demand has grown they have begun to convert their learning package to a flexible learning format to accommodate short courses and distance education. With the assistance of ACRE the BIT group is now preparing its Certificate IV course for print-based distance education and online study via the World Wide Web. They will also make it available to other TAFE colleges in Australia and also to international customers who are experiencing a sudden surge in demand for training packages for renewable energy installers, designers and maintenance technicians. The BIT/ACRE package is likely to be adopted nationally by the National Training Authority and it will greatly assist the renewable energy industry by providing a thorough, high-quality and nationally accredited package for training the additional technicians and tradespeople needed to support the growth of the industry.

This package is not a conventional engineering technology or electrical trade course with a few additions relating to renewables but a completely new approach that addresses renewable energy systems and their design, installation and maintenance. It was developed in consultation with the renewable energy industry around Australia. Course modules were written by renewable energy experts with industry development committees overseeing the final syllabus. Such courses are essential to ensure that we have an adequate supply of well-trained tradespeople who can design, produce and maintain reliable and cost effective systems. High quality educational packages of this type are as important as the technology itself for ensuring quality of the product and success of the industry.

4.2. 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 young 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, 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 (Jennings, 1996; Jennings and Lund, 1999; <http://www.wacre.murdoch.edu.au/education/>).

When ACRE was established in 1996 it began funding the conversion of these print-based external units to on-line study and the Postgraduate Diploma in Energy Studies and Master of Science in Renewable Energy are now both fully available on-line. These courses attract significant numbers of external students from throughout Australia and overseas. 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 online delivery. Many of the graduates of these courses 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 (Jennings and Lund, 1999).

The success of these courses has led to international demand for them and arrangements are now in place to offer them via licence agreements in India and Iran. These courses are also offered to engineers through the Engineering Education Australia network. In addition there are many private overseas students from countries such as the USA, Canada, New Zealand, France, Singapore and the Philippines enrolled in these courses.

4.3. Photovoltaic Engineering

The Key Centre for Photovoltaic Engineering at the University of New South Wales, led by Professor Stuart Wenham, opened for business in 1999. One of its key objectives is to offer a new type of engineering degree devoted to solar energy and photovoltaic engineering. The first intake of students into this course occurred in 2000. This campus-based course contains a blend of traditional engineering subjects together with new units in areas such as PV design and manufacturing, grid connected and building integrated systems, wind power systems, biomass conversion, solar thermal and applications of these technologies. Students also have some freedom of choice to select areas of specialisation and to enrol in double degrees to enhance their employment opportunities. This course aims to address the industry needs for engineers to research, design and install major new renewable energy systems, particularly those based on photovoltaics. (Wenham *et al.*, 2000a)

4.4. Renewable Energy Engineering

In collaboration with Western Power Corporation and the University of NSW, Murdoch University's School of Engineering is preparing to offer a new campus-based course in renewable energy engineering from 2001. It will also cover traditional engineering subjects plus major renewable energy technologies such as wind, biomass, solar thermal and photovoltaics, and their applications. This course was initiated at the request of Western Power, who perceived a need for renewable energy engineers to support its program of development of renewable energy technology for green power and the 2% scheme. (Wenham *et al.*, 2000b)

4.5. Short Courses

The rapid development of renewable energy technology and the changing market conditions have produced a demand for specialist short courses on topics such as renewable energy technologies, system design, maintenance, installation, power quality, applications and energy policy and economics. Industry bodies such as SEIA and the Electricity Supply Association of Australia (ESAA) have attempted to provide such courses, but as the demand has grown several Universities and ACRE have entered this field. The University of Melbourne offers short courses in renewable energy for developing countries. The University of NSW, with assistance from ACRE, has offered short courses in PV applications and RAPS system simulation. Curtin University of Technology, with assistance from ACRE, has offered short courses on power quality, solar water pumping and passive solar design.

ACRE also has an active short course program and works with specialists to provide short courses for which there is an identified demand from industry or the public. Some of ACRE's offerings include emissions trading, electricity sector reform and renewables, renewable energy technologies, RAPS design. ACRE is also planning short courses on battery maintenance, power quality and biomass conversion in collaboration with other institutions and specialists.

ACRE and the Key Centre for Photovoltaic Engineering also organise conferences, workshops and seminars for the general public, teachers and school groups as a public service in order to build confidence in the renewable energy industry.

ACRE has an extensive web site with many educational materials that students and teachers can access and use, free of charge at <http://www.acre.murdoch.edu.au/school/>.

These activities are all regarded as an important part of market development for the renewable energy industry and they are generally well supported by the public. (Jennings, 1996)

5. New Techniques for Renewable Energy Education

Because of the urgent need for on-the-job training as well as the conventional face-to-face training in renewable energy we have utilised modern educational technology to reach a wider audience.

The World Wide Web provides an excellent vehicle for teaching students off campus. It is well suited to the needs of professionals, who cannot attend classes on campus as well as schoolteachers, students and consumers who wish to access information from their homes and workplaces. We have been able to provide high quality materials to schools via Internet sites and CDROMs. These materials include lesson plans, information files, demonstrations and links to other relevant Internet sites. Because students and teachers are generally familiar with the World Wide Web they can readily access these materials without the need for assistance from our small staff. This ensures efficient dissemination of information about renewables to a global audience (O'Mara and Jennings, 2000).

We have also used the World Wide Web for delivering University courses in energy studies and renewable energy to a national and international market. The team at BIT is also developing their TAFE courses for international delivery. Our experience has demonstrated that the Internet is a powerful and effective tool for distance learning (Lund and Jennings, 1997, 1998, 2000; Lund *et al.*, 2000). It provides a wealth of resources for isolated students and most of this information is very up-to-date. The Internet courses can be studied wherever the students are and at a time and pace that suits them. Email also enables students to submit queries and assignments from anywhere in the world and receive rapid feedback from their instructors.

We have also developed "picture book" laboratory sessions for isolated students who cannot attend on campus. These enable them to learn the techniques of data analysis and experimental design, although they miss out inevitably on some of the manual skills involved in collecting their own data. However for postgraduate students this is less of a problem than it would be for undergraduates because most of them already have extensive practical experience in their own fields (Lund and Jennings, 2000).

For those students who do not have Internet access, or for whom it is costly or unreliable, we have provided courses on CDROM. The University of NSW is also using this medium effectively in their university level and short course training.

There are some disadvantages of the Internet compared to face-to-face teaching (Lund and Volet, 1998; Lund and Jennings, 1999). For example students do not have direct access to their lecturer and cannot enjoy the interaction that occurs in a conventional tutorial. However many part time and external students have never had these privileges and the Internet now provides them with a wealth of resources and quick feedback from experienced staff when they encounter difficulties. So popular is this mode of study amongst professionals that over 80% of the students enrolled in our postgraduate diploma and MSc have chosen to study in this mode. For undergraduates it is likely that more would prefer conventional classroom teaching, but even in such cases the Internet provides access to a wealth of information and a convenient way to submit assignments to their instructors.

6. Future Trends In Renewable Energy Education

As the renewable energy industry develops, as a result of technological advances and market demands, there will be a substantial increase in demand for trained professionals. It is crucial to the success of the industry that we maintain the highest standards of performance and efficiency so that consumer confidence will continue to grow and we can shed forever the image that renewables are unreliable and only of limited value in real power generation systems. There have been too many occasions in the past where renewable energy systems have failed to achieve the level of performance expected by the

customer. In some cases this was due to misrepresentation by sales persons but in many others it was due to poor quality design, installation or maintenance. Such failures damage the reputation of the industry and can in serious cases lead to rejection of the technology. Nuclear power is a good example of how a promising new technology has failed because of unsolved technical and social problems and inadequate training of operators and designers.

Education and standards are the keys to quality renewable energy systems and market confidence. Education provides courses to train professionals and it provides information to consumers about the technology and its performance. Quality is also essential in educational products and in many fields professional bodies keep a watching brief on course content and the qualifications of the instructors. This has not happened to any great extent so far in renewable energy but it is now timely to consider appropriate accreditation procedures for courses.

The formal education system is unlikely to be able to keep pace with the needs of the renewable energy industry during the period of rapid growth that lies ahead. Therefore it will be necessary to use modern educational technology to provide in-service training for professionals who wish to enhance their knowledge of various aspects of renewable energy. As lifelong learning becomes an integral part of modern industry they will want access to advanced award courses and to short courses from time to time (Whyte, 1999). The renewables field is developing so rapidly that the short training course area is likely to be crucial to the needs of industry over the next 20 years. Even recent graduates will need to update their knowledge on the job and this will be done via continuing professional education courses using flexible learning packages. ACRE already supplies some of these courses to engineers via Engineering Education Australia, which specialises in continuing professional education for engineers via distance education.

Many countries are now realising the need to move rapidly into renewable energy and they are seeking courses that meet their needs. The Internet has created a global market in courses and Australian institutions are competing strongly to supply appropriate training packages to meet the needs of international customers. There is likely to be a huge demand for specialised short courses on areas like design and installation of roof top systems, RAPS system design and installation, renewable energy systems maintenance, power quality for renewables and energy policies. The TAFE courses for designers, installers and maintenance personnel will also have wide application as they address the immediate needs of nations wishing to install more renewable energy systems. Renewable energy education is poised to develop a significant international market with a large export potential and good return on investment. With our distance education and Internet experience in renewable energy, Australia is well placed to service these needs.

User education is likely to be another area where considerable work is required. Renewable energy technology is novel and users will need training to select and use it effectively. The computer industry and the automobile industry have both recognised the vital link between education and market development and have addressed it effectively to ensure that consumers are given the knowledge they need to make wise choices and to get the best value from their investment. The renewable energy industry will need to do likewise if it wishes to reap the full benefits of public support and the desire of people to find safe, sustainable energy systems for the future.

Good engineering and market demand are clearly essential for the prosperity of the renewable energy industry, but they are not sufficient. Unless the systems are meeting consumer needs, there will be an adverse reaction and the demand will decline. Education and training must be provided at all levels from customers to managers to ensure that renewable energy systems meet the highest standards of reliability and efficiency. Renewable energy must shed its Cinderella image and prove to society that it can achieve the standards expected of modern technology.

In order to achieve this objective government and industry will need to put more funding into renewable energy education and research. They must integrate and focus their efforts to address training needs and to ensure that courses address the needs of society and achieve the standards required. This means that industry, government and educational institutions will need to work closely together to help build this new power generation industry. This may occur through government initiatives like CRCs or Key Centres or through industry-sponsored research and development boards. These models have achieved some success in the Australian context. However it is also important for the industry and professional societies like ANZSES and SEIA to take a lead in establishing this cooperation. In the current situation universities and TAFE colleges are desperately short of funds and all new initiatives are dollar-driven. The only way that these initiatives will come about is if industry or government provides additional funding to facilitate them.

7. Conclusion

Several new approaches to renewable energy education are being trialled at present. These are based on an assessment of the needs of industry and society. They are based in a different educational approach to conventional energy education and the make use of flexible, modern educational technology to reach a worldwide audience, including distance education students. The outcomes of these new courses will be crucial in assisting the industry and government to make a smooth transition to a greater reliance on sustainable energy systems for power generation.

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