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Using the Internet to Enhance Post Secondary Renewable Energy Education

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Abstract

There is a pressing global need for more trained scientists, engineers, policy makers, technicians and tradespeople with the knowledge and skills to develop, implement and maintain renewable and energy efficient systems and policies. This training requires the development of high quality, flexible renewable energy training courses that can be delivered by both face-to-face and self-paced distance education. The Internet's unique features, including its ability to display not just static, but dynamic, information to anywhere in the world almost simultaneously means it can be used to significantly enhance the learning experience of students. In the light of this the Australian Cooperative Research Centre for Renewable Energy (ACRE) in conjunction with Murdoch University and the Brisbane Institute of Technical and Further Education (BIT) are developing a number of internationally focussed distance education and Internet based post secondary, and tertiary level renewable energy courses. The individual modules, or units, that make up these courses have been developed for maximum flexibility with the option of delivery face-to-face or through distance education. There are a number of challenges in delivering renewable energy training by conventional correspondence based distance education. These challenges can be reduced, and the quality of learning significantly enhanced by the use of the Internet. Some of the advantages of using the Internet to enhance post secondary renewable energy education will be discussed. A number of examples of how the Internet has been used to enhance ACRE's post secondary and tertiary level online modules and units will be shown. A number of Internet based resources useful for renewable energy training will also be given.

1. Introduction

Rising international concern about global warming and the rapid development of the renewable energy industry over recent years has led to a need for multidisciplinary programs in renewable energy at all levels from post secondary trade level to postgraduate tertiary level. There is a pressing global need for more trained scientists, engineers, policy makers, technicians and tradespeople with the knowledge and skills to develop, implement and maintain renewable and energy efficient systems and policies. This training requires the development of high quality, flexible renewable energy training courses that can be delivered both face-to-face and by self-paced distance education.

The Australian Cooperative Research Centre for Renewable Energy (ACRE) is dedicated to the development of effective renewable energy solutions to power supply problems. Its education program was designed to provide a sound technical base in renewable energy technology in order to support and enhance its research capacity (Jennings, 1996, 1997). However it also addresses the need for ecologically sustainable development by covering the social and environmental aspects of energy use as well as the economic and policy issues. ACRE, in conjunction with Murdoch University and the Brisbane Institute of Technical and Further Education (BIT) are developing a range of high quality,

Internet based post secondary and tertiary level renewable energy training courses that are accessible to students all around Australia and the world. The courses being developed range from post-secondary trade level through to postgraduate Masters. They seek to ensure that the students receive an education that equips them to work on new energy systems that can be used to build a sustainable energy industry for the future.

Since the beginning of 1997 ACRE and Murdoch University in Western Australia have been developing a program in Energy Studies that is based on the principles of ecologically sustainable development. As part of this program a range of internationally focussed, online (Internet-based) university courses in renewable energy technology, energy policy, energy economics, energy efficiency and greenhouse issues has been developed. This includes a number of units and programs at the university undergraduate and postgraduate level that are available for both internal (on campus) and external (distance education) study. The program is offered on campus and by distance education, via the Internet, throughout Australia and overseas. In 1999, the Renewable Energy Centre (REC) of the Brisbane Institute of TAFE in Queensland, in collaboration with ACRE, commenced a major 2-year project to make high quality, practical, trade level renewable energy training accessible to students anywhere in Australia (or the world). The *Certificate IV in Renewable Energy Technology* is a nationally (Australia) accredited 2.5-year part-time technicians' course consisting of approximately eleven modules and provides training in the design, installation and maintenance of renewable energy systems. The key modules of this certificate, which have previously only been available face-to-face, are now being developed for self-paced, flexible, distance education delivery. This includes both print-based correspondence and Internet based versions of the modules.

The units and modules are designed to enable the unit material to be offered in the same way to as wide a range of students as possible, taking into account their different geographical situations by making significant use of the Internet to enhance the delivery of the renewable energy training. As well as making use of the increasing amount of relevant, contemporary material available via the Internet (such as **http://www.windpower.dk/**), the units use the real-time, geographically independent interactivity and communication available though the Internet to enhance the learning of the students.

Over the last three and a half years the tertiary level online renewable energy courses have been developed and offered nationally and internationally. The operation and effectiveness of these units was monitored during the initial trial period, and later during full implementation, by gathering extensive feedback from the students themselves. This evaluation has led to a number of observations about offering online courses and it is clear that the advantages are many. The use of the Internet has the potential to not only significantly increase the number of people who can receive training in renewable energy but can greatly enhance the learning experience of the students, in both face-to-face and distance education modes of study. This paper will discuss some of the advantages of using the Internet to offer post secondary (trade) and tertiary level renewable energy education. A number of examples of the use of the Internet to enhance ACRE's renewable energy modules and units will be shown.

2. The Post Secondary Trade Level Program

The *Certificate IV in Renewable Energy Technology* is a nationally (Australia) accredited technicians' course consisting of approximately eleven modules and provides training in the design, installation and maintenance of renewable energy systems. The course was developed in 1986 in consultation with the renewable energy industry around Australia. Course modules were written by renewable energy experts and industry development committees oversaw the final syllabus. The course has been taught in a face-to-face mode at a number of Technical and Further Education (TAFE) colleges since its inception. The course is organised into core and elective modules. To be awarded the

Certificate students need to achieve competency in each of the core modules (approximately 280 hours) and in a choice of elective modules (320 hours) totaling a nominal 600 hours. Students 'graduate' though when they are competent at achieving the set outcomes for each module, rather than when they have been in attendance for a certain number of hours. Modules include:

Core modules*; Introduction to Renewable Energy Technologies; DC and AC Electrical Fundamentals; Extra Low Voltage Electrical Wiring and Practice; Introduction to Electronics for Renewable Energy Systems; Word Processing; Spreadsheet Fundamentals;* and *Using a Personal Computer.*

Elective Modules; *Solar Water Heating Systems; Hybrid Energy Systems; Wind Energy Conversion Systems; Energy Efficient Building Design; Client Interaction;* and *Computer Graphics Fundamentals.*

The modules are usually offered in part-time mode with evening classes, and the complete Certificate IV would usually take about two to two and a half years to complete, depending on the workload taken. *Introduction to Renewable Energy Technologie*s has been available for distance learning students since 1998 with the development of a print based Resource Book, Learning Guide and Assessment Package. Since the beginning of the ACRE project in 1999 *Introduction to Renewable Energy Technologies* has been converted to Internet delivery, and *Energy Efficient Building Design* has been developed for offering by distance education, and is currently being converted to Internet delivery. Other modules of the Certificate IV are currently being developed for distance education delivery and it is expected that all the renewable energy modules will be made available progressively in both paper based and Internet formats by the middle of 2001. Both the paper based and Internet versions of *Introduction to Renewable Energy Technologies* and the paper-based version of *Energy Efficient Building Design* are currently being trialed at BIT. More details of the structure of the course, and content summaries of each module are available from the website at **http://www.acre.murdoch.edu.au /rec/** .

3. The Tertiary Level Energy Studies Program

Conventional energy education has generally failed to adequately address the need for ecologically sustainable development. In designing the tertiary level Energy Studies program it was decided to specifically address the criteria for ESD and this led to an entirely new curriculum (Lund and Jennings, 1999). The full postgraduate program that has been developed requires two years of full time study. In the first year the units offered include; *Energy in Society, Energy Management, Energy Economics, Energy Systems, Energy Policy* and *Energy Studies Project.* These six units constitute the Postgraduate Diploma in Energy Studies, which can be studied on campus or entirely externally via correspondence, or the Internet, and can be completed in one year of full-time study or over several years part-time.

Following the completion of the Postgraduate Diploma, students who wish to gain more specialization in renewable energy technology may complete a further year of study and research to obtain a Master of Science (MSc) degree. The additional units available in the MSc program are, *Renewable Energy Resources, Renewable Energy Conversion Devices, Renewable Energy Systems Design* and *Case Studies of Renewable Energy Systems*. The MSc also includes a dissertation that accounts for one third of the student's time over the year and involves a practical investigation of a renewable energy system or device. These units can be studied on campus or entirely externally via correspondence, or the Internet and can be completed in one year of full-time study or over several years part-time. As well as being part of the formal qualifications the individual units can be taken for professional development or as part of an undergraduate degree.

The Postgraduate Diploma in Energy Studies has been available via face-to-face and correspondence based distance education since 1992. Following the creation of ACRE the Diploma was developed for online offering beginning in 1997, and offered via online distance education nationally in 1998. The full two years of the MSc have been offered online nationally and internationally since 1999 and has attracted a substantial response. The MSc program currently has close to 60 students, up from 5 in 1996, with the majority of these studying externally and not attending the campus. These students study from home in most states of Australia, with International students currently studying in the USA, India, the United Kingdom, Singapore and New Zealand. A number of Australian students are currently studying in overseas countries such as France, Canada, the United Kingdom, Cambodia and Japan. Most of the local and interstate, and all of the overseas students are studying online using the Internet version of the units. The types of students taking this program and their reasons for doing so have been reported in detail elsewhere (Lund and Jennings, 1999). Further details about the program and the individual units themselves are available from the ACRE website **http://www.acre.murdoch.edu.au/education/** .

4. The Advantages of Online Delivery

The renewable energy units and modules offered by ACRE, Murdoch University and BIT have a diverse target student market. Students can come from a wide range of backgrounds and requirements. They are widely spread geographically, with some studying on campus, while others are interstate and overseas and can only study via distance education. The renewable energy course offerings were therefore developed in such a way that they can be used by all of the different types of students in a similar way. In order to make the units relevant to the widest possible audience, flexible programs were developed based on a range of internationally focussed units and modules available online (via the Internet). The advantages of offering the units online include:

- *Greater access* - the potential to reach a greater number of students because the units can be completed via the Internet, from CDROM, or a mixture of both, without the students having to come onto campus.
- *Greater choice of instructional methods* - the ability to introduce interactive multimedia and simulations into the units via the Internet, or CDROM, means a greater range of teaching options are available. This means that the learning experience can be greatly enriched beyond that normally available from print based material, especially for distance education students.
- *Greater flexibility* - the convenience of studying in the comfort of the student's own surroundings, at a time and pace that suits them, means that online presentation is well suited to professional development and part-time studies.
- *Greater relevance* - the ability to use Internet resources that are continually updated means that it is easier to keep information in the units up to date and relevant. The use of hyerlinks to other websites enables the introduction of materials from a wider range of sources and adds interest and global awareness to the curriculum.
- *Greater opportunity for course sharing* - because the unit content is available via the web it is easier to share units between campuses or even educational institutions. The same content can be accessed from the web, with local tutorials and laboratories, where desired.
- *Better communication* - email and online discussion groups enable significantly faster and more convenient student-student and student-teacher interaction, electronic submission and marking of assignments, and help with problems, especially for geographically isolated external students. As electronic communication has no geographical constraints there is the potential for increased interaction between students from a wide range of countries and backgrounds who can share different perspectives on the material.

- *Easier course maintenance and administration* - once developed the units are generally easier for the academic and the educational institution to maintain and administer as changes can be made to the material on the website and this will instantly be available to all the students.

It is clear that there are many advantages of offering renewable energy studies via the Internet. It has the potential to significantly increase the number of people who can receive training in renewable energy and to greatly enhance the learning experience of the students, especially those studying via distance education. This has been clearly seen in our experience of offering Energy Studies units online.

5. The Design of the Online Units and Modules

The online units and modules were designed to enable the unit material to be offered in the same way to as wide a range of students as possible. This was best achieved through the units having a common interface and format that could be used effectively by both internal (on campus) and external (distance education students). In light of this the approach taken was to design the unit material so that it was accessed via a World Wide Web browser interface. This meant it could be served from an Internet server or from CDROM in the same way. All internal and external students who use the Internet mode of study access the unit material in the same way. For these students the unit material usually consists of a range of media. This includes published textbooks or technical brochures, printed course readers or resource books containing compiled supplementary material, online and multimedia material provided via the host University, either from a server or CDROM, and links to other non host University sites on the Internet.

The design of the Internet sites for the units and modules was based on contemporary teaching and learning theory and practice (Brown, 1997). The instructional design aim of the Internet sites was to provide a rich learning experience in a personalised supportive framework, while at the same time promoting self-discipline and requiring students to take a more active approach to their learning. A hypertext approach to presenting the information also enables students to self-pace, either exploring issues about a topic of interest more deeply, or spending less time on concepts that are already understood. Computer mediated communications systems, offer a potentially rich social learning environment that can support and facilitate active learning collaboration.

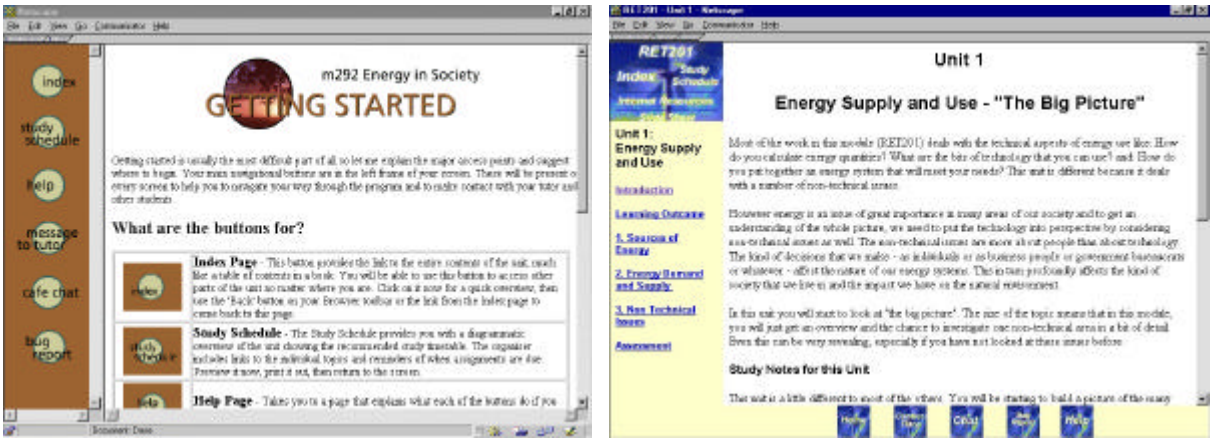

Figure 1. Left to right. The first page of the online unit *Energy in Society,* and a unit page from the online version of the module *Introduction to Renewable Energy Technologies,* as seen using the Netscape Browser.

With these considerations in mind, the interfaces were designed in a frame format with navigation bars as fixed constants on the screen, and a larger scrollable right hand "content" frame containing the hyper linked topics. The navigation bars appear on every screen in the same place, no matter which hyperlinks (whether these are local or external) the student chooses to follow in the content frame. Thus the common problem of getting lost in the hypertext web is overcome with fixed navigation bars. Almost all the internal and distance education students use the online versions of the *Energy Studies* units and have expressed high levels of satisfaction with their online delivery. Figure 1 shows the first page of a typical *Energy Studies* online unit, and a typical *Certificate IV in Renewable Energy Technology* online module showing the online interface and gives an idea of the features of the interfaces. Demonstration versions of the *Energy Studies* units developed so far can be viewed at the ACRE website **http://acre.murdoch.edu.au/education/** .

6. Demonstrations of Internet Enhancements

Although the Energy Studies students, when surveyed, did not report any significant drawbacks to studying online, our experience and research have shown two major challenges with offering renewable energy courses via correspondence based distance education. One of these is a loss of face-to-face contact with university staff and other students. The other major challenge, specific to all Science-based courses, including renewable energy, is that of a reduction in practical, hands on experience. Although these problems cannot be entirely overcome, there are a number of ways in which they can be reduced. The use of the Internet offers significant advantages over conventional distance education delivery methods such as print based correspondence in reducing these problems and greatly enhances the learning experience of students. Some of the ways this has been done in ACRE's courses are demonstrated below.

The loss of face-to-face contact with university staff and other students is one of the primary concerns for students who are taking correspondence based distance education courses. Online delivery enables much greater teacher-student and student-peer support for distance education students. Computer mediated communications systems, offer a potentially rich social learning environment that can support and facilitate active learning collaboration. This is especially true for distance education students who are normally isolated from one another and do not have the same face-to-face interaction enjoyed by on campus students. Students in this environment are no longer "passive learners attempting to mimic what they see and hear from the expert teacher" (Berge & Collins, 1995), but more active participants in the construction of knowledge and meaning. The use of email and electronic discussion groups/bulletin boards can greatly reduce the isolation normally felt by distance education students, and they value this kind of interaction.

The fixed navigation bars (see Figure 1) of all the online units and modules contain links to the computer mediated communications systems and help/support features of the module websites, ensuring they are an integral and easily accessible part of the websites. These features are easily accessible from anywhere in the website enabling students to communicate with each other or their tutor at the place in the content where they are at the time. Should students have particular learning problems that can't be resolved by themselves, or in discussion with their classmates, they are able to contact their tutor at any time, through the Contact Tutor button. Any email sent to the tutor is private. The Contact Tutor email facility helps to establish a learning environment that is helpful, responsive and most importantly, human and its inclusion on the navigation bar helps to remind students that they have not been abandoned. Students can submit their assignment work electronically, as attachments to email, and these are marked by the tutor and returned in the same way. This enables a much more rapid turn around time for students to receive feedback on their work than is possible with conventional print based correspondence courses.

Collaborative learning is supported in all the units and modules by the inclusion of electronic discussion groups or bulleting boards. These can either be threaded or unthreaded, and used for structured, formal interactions, or unstructured student driven discussions or activities. Figure 2 shows two examples of computer-mediated communication from the *Energy Studies* units. The first example is from the Café Chat of *Energy Economics*. The Café Chat is an unthreaded, unstructured electronic discussion list, included in all of the Energy Studies units. It is fully automated for ease of use and all members of the online class can read all the messages posted there. The Café Chat facility is always located on the fixed navigation bar to give prominence to its importance to learning in the unit and to enable learners to access it no matter where they are in the topics. In the first example in Figure 2, an online American student is using the Café Chat to introduce himself, to encourage links and interaction with other students, and to kick start a discussion about the material being studied at the time. The Café Chat immediately has a response from another online American student who takes up the discussion, adding his viewpoint. This example demonstrates how because electronic communication has no geographical constraints there is the potential for increased interaction between students from a wide range of countries and backgrounds that can share different perspectives on the material.

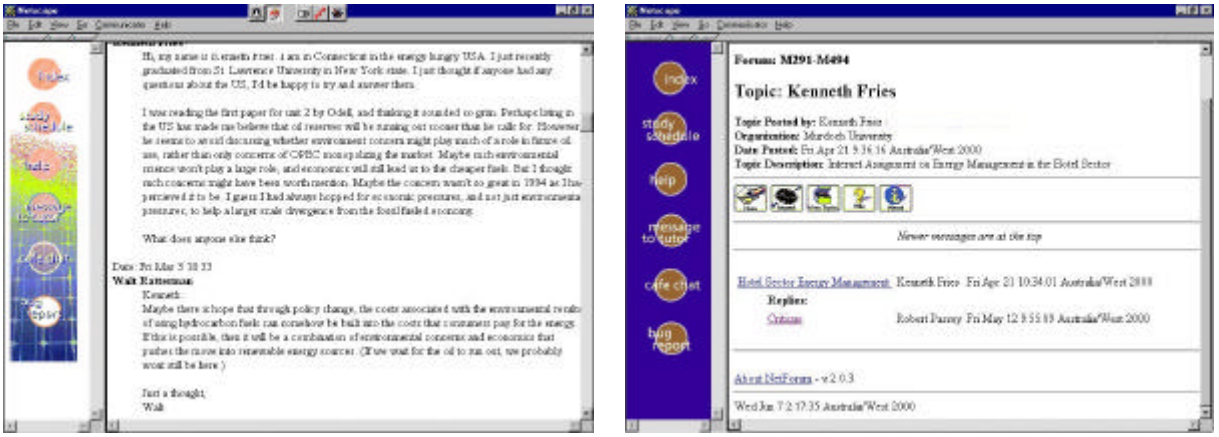

Figure 2. Left to right. An example of the unstructured, unthreaded Café Chat discussion group from *Energy Economics* and the structured, threaded NetForum Internet exercise from *Energy Management*.

The enhancement of student's learning gained by using Internet based computer aided communication is clearly demonstrated later in the Energy Economics Café Chat in a message from an external student who says:

> *"Greetings everyone. My name is Colin Heinzman. I live about 35 km south of Perth, Western Australia and I've been studying this course online since Feb '99. It's a great way to study and it saves a lot of traveling time and expense (and energy!).The only problem is missing out on live tutorials and discussion. However, Andrew's and Walt's comments gave me the thought that perhaps we could put our answers to each week's Discussion Topics onto the Cafe Chat and create our own cyber-tutorial! Anyway, here are my answers to questions for Topic No. 1. Please be as critical of them as you like (we are all a little too far away for any possibilities of fisticuffs developing):"*

This further demonstrates how computer mediated communications systems support and facilitate active learning collaboration especially for distance education students who are normally isolated from one another. As the discussion list provides a written transcript of the online discussion, it can build into a rich resource, a collaboratively built knowledge base about the topics being discussed. Webb (1989), in a message map analysis of interaction patterns in discussion lists, found that students do respond to the messages of others, adding to and building on the ideas proposed. As this facility is also available to,

and used by, the face-to-face students it also enhances they're learning, and exposes them to viewpoints from international students with whom they would not usually interact. This facility also offers the unit coordinator the ability to inform all students of any thing related to the unit, any changes or relevant new resources in the one place without having to contact them individually.

The second example in Figure 2 is of the use of a structured, threaded NetForum discussion in an Internet exercise in the unit *Energy Management.* In this exercise students are firstly required to formulate an Energy Management plan for a hospital, hotel or commercial building, using Internet based case studies as examples of where the strategies proposed have been successfully used before, and post them to the NetForum discussion group. When all of the management plans have been posted the students are then required to read several of the plans, and to post a critical assessment of one of them. This exercise enables students, both face-to-face and distance education, to be involved in peer review of their work, in a similar way to that which occurs in the workplace. It also enables them to build a rich, collaboratively built resource of case studies and examples of energy management strategies and plans. It is clear from the two examples that the use of the computer assisted collaborations available through the Internet can significantly enhance the learning of both face-to-face and distance education students, especially the latter.

One other important problem mentioned by a number of students, particularly those with a Science or Engineering background, is that distance education units do not provide the same amount of practical hands on experience as face-to-face classes. Although this is clearly a difficulty with offering distance education in any Science or Engineering based unit that has a practical component, and it cannot be overcome entirely, there are a number of ways that it can be reduced, and online delivery offers a number of advantages over conventional print-based distance education in this regard. Some of these advantages stem from the ability to incorporate many more types of media and to use real time data collection and equipment control. Examples of some of the features that have been incorporated into ACRE's online renewable energy units and modules include:

Figure 3. A typical screen from "The Sun's Joules" CDROM showing the incorporation of video clips in online renewable energy courses.

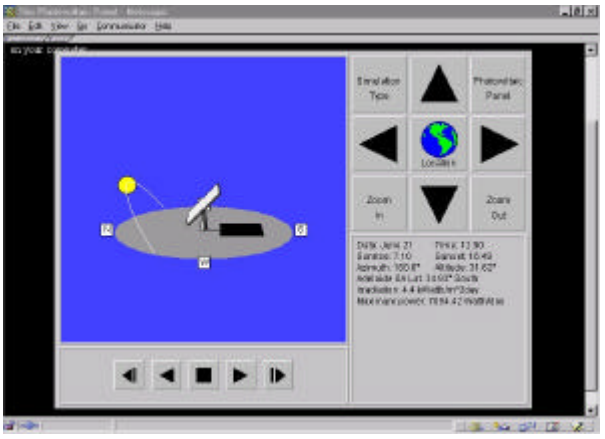

Figure 4. A typical screen from the web based solar simulation program SolarSim. This demonstrates the use in renewable energy teaching of Internet or CDROM based simulation programs.

- *Multimedia*. The Center for Renewable Energy and Sustainable Technology (CREST) have developed a very good, inexpensive, interactive CD entitled "The Sun's Joules" which contains a large amount of information on various renewable energy, energy conservation and climate change topics. One of its features is the incorporation of multimedia movie clips showing various aspects of the

content being discussed. A typical multimedia video clip from "The Sun's Joules" is shown in Figure 3. An Internet version of this CDROM can be found at **http://solstice.crest.org/renewables/SJ/** , but due to bandwidth considerations this site does not have the multimedia movie clips. This is only one example of the growing number of other such resources available.

- *Simulations*. A number of simulations of renewable energy systems are now becoming available. These range from simple interactive demonstrations such as the SolarSim program developed by the Australian National University (Hume and Cuevas, 1997) to complex system simulation and analysis tools like RAPSIM, which has been developed by the Murdoch University Energy Research Institute (MUERI). A web based version of the SolarSim simulation (shown in Figure 4) is available at **http://online.anu.edu.au/engn/solar/Sun/** . These simulations, which are available as online simulations (SolarSim) or can be downloaded as stand-alone programs (RAPSIM) from the Internet or CDROM, can be incorporated into the online units to give more practical experience.

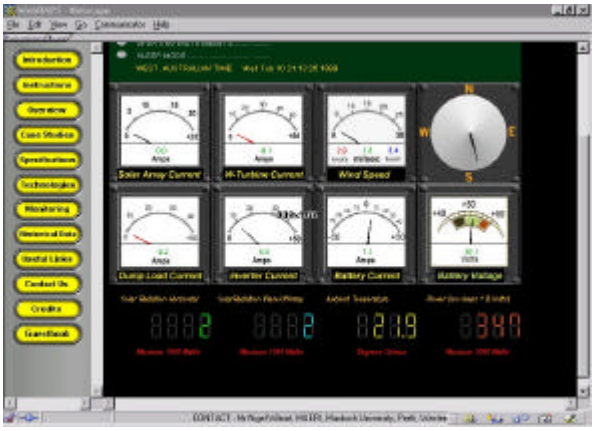

Figure 5. A typical screen from the WebRAPS website that demonstrates the enhancement of renewable energy teaching possible through an Internet interface displaying real-time data.

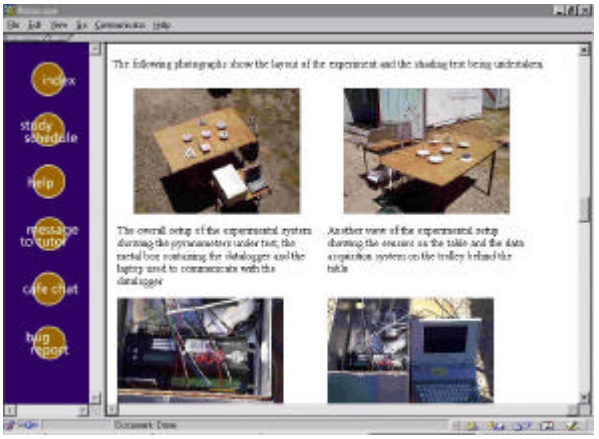

Figure 6. A screen from the online unit M521 Energy Conversion Devices showing part of a storybook laboratory.

- *Interface to real renewable energy equipment and systems*. A number of Internet sites are now being developed which incorporate a computer interface to enable the collection and display of data from a real world system. These systems, which can display data in close to real time, enable the user to see the system in operation and to measure its performance without actually having to be at the physical site. One such site is the WebRAPS site developed by MUERI and ACRE. This website at **http://wwwphys.murdoch.edu.au/WebRAPS/** is designed to display both meteorological and system performance data in close to real-time for the physical remote area power supply (RAPS) demonstration system at MUERI. The WebRAPS site, shown in Figure 5, and described in more detail elsewhere (Lund *et al*, 1998), enables a user to see how the system operates without actually having to visit the physical site itself, but rather by monitoring its performance over the Internet. This site is used in both the *Energy Studies* and *Certificate IV in Renewable Energy Technology* courses.

- *The use of storybook practicals and site visits*. In order to further expose online distance education students to the skills and techniques needed to undertake practical tasks related to renewable energy applications ACRE have been developing a series of virtual, or storybook, laboratories and site visits. The storybook laboratories consist of a series of instructions and clear digital pictures showing how the laboratory, or practical session, is completed step by step. The students are then able to download in electronic form actual results obtained from the practical, which they are then required to

analyse and report. An example of such a storybook laboratory is shown in Figure 6 and an Internet version can be viewed by following the External Students link at **http://wwwasu.murdoch.edu.au/teach/acre/m522demo/laboratories/m522lab1/m522lab1.htm** .

Similar virtual, or storybook, site visits are being developed to enable distance education students to gain a more realistic feeling for what it was like to be at the site than would be possible from just a written description of the site. The storybook laboratories and storybook site visits developed so far have proven to be an important enhancement to the practical laboratories for the distance education students. Although they cannot replace practical hands on exposure to the necessary equipment, they can greatly enhance the students understanding of the techniques and methods involved. They enable the online students to more closely integrate the practical and theoretical components of the units than would be possible from either a straightforward analysis of supplied results, or no laboratory component at all. If necessary the online students could be required to later complete the laboratories during an intensive laboratory session or attend an industry or campus centre thereby enabling them to acquire the competence and practical skills needed. The use of the storybook laboratories enables these students to become familiar with the laboratory techniques required in advance, thereby reducing the amount of time required to gain these skills during the actual intensive session. The storybook laboratories have also proven popular with the face-to-face students who use them as prelabs in order to become familiar with the laboratory before doing it.

One other feature of the Internet is that it enables the use of computer assisted, interactive activities to reinforce student learning. These "computer aided learning" activities enable students to test their knowledge and understanding of content areas by receiving feedback on their answers to a series of questions. As the computer assesses the answers to the exercises the students can repeat the exercise as many times as necessary, at times that suit them, until they are happy with their competence. This also reduces the need for individual feedback from the tutor, with the associated reduction in workload. Two examples of where these computer aided learning activities are used are in the unit Activities and the Self Checks in the online *Certificate IV in Renewable Energy Technology* modules. Activities and Self Checks are designed to jog students memories about what they already know, to stimulate them to think things out in advance, or to help reinforce their learning and recall. They usually require either short answer or multiple-choice responses, often involving calculations.

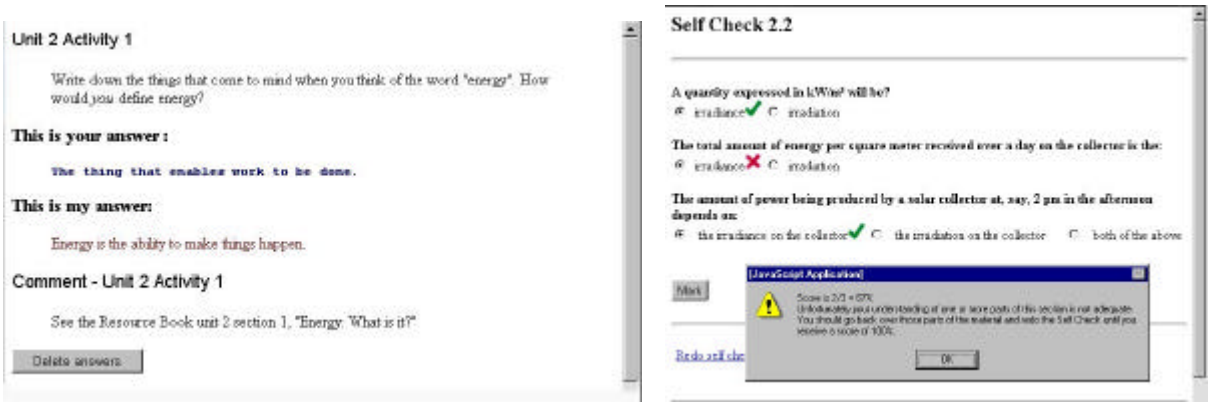

Figure 7. Two examples of Javascript interactive computer aided learning from the *Introduction to Renewable Energy Technologies* module. From left to right, the response screen of an Internet feedback Activity with the computer's response if the student is on the right track, and the response screen of a Self Check showing the computer scored multiple choice test where not all of the answers are correct.

Some of the Activities and Self Check exercises in the *Certificate IV in Renewable Energy Technology* modules have been converted to interactive, computer aided learning exercises using

simple Javascript scripts. These enable students to submit their responses to set short answer questions or multiple choice tests and have them checked by the computer, receiving constructive feedback to aid them in their learning. Examples of an interactive short answer Activity and an interactive multiple-choice Self Check exercise are shown in Figure 7. The first example shows the computer response for a student's answer to an Activity question requiring a short answer response, where the student is on the right track. This enables the student to see feedback on their answer, and to see how closely their answer reflects what was being sought. If the student enters an answer that is wrong the computer responds telling them that their answer could be better and gives them a hint to assist them in finding the right answer. The second example in Figure 7 shows a response from the computer for a multiple-choice test. After the student chooses their multiple choice answers (which can include graphics) the computer marks the test showing graphically (with ticks and crosses) which responses were correct or incorrect and giving a score for the test. Students can repeat the Javascript feedback exercises as many times as they wish until they get the correct answer/s before moving onto the next section.

7. Conclusions

The Australian Cooperative Research Centre for Renewable Energy (ACRE) in conjunction with Murdoch University and the Brisbane Institute of Technical and Further Education (BIT) are developing a number of internationally focussed distance education and Internet based post secondary and tertiary level renewable energy courses. It has been shown how a number of the challenges in delivering renewable energy training by conventional correspondence based distance education can be reduced, and the quality of learning significantly enhanced by the use of the Internet. Some of the advantages of using the Internet to address two of these challenges, the loss of face-to-face contact with university staff and other students and a reduction in practical hands on experience and its use to enhance renewable energy education in general have been discussed in more detail. A number of examples of how the Internet has been used to enhance ACRE's post secondary and tertiary level online modules and units have also been shown.

8. Acknowledgments

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