International
Specialised
Skills
Institute Inc

Victoria
The Place To Be

ALTERNATIVE ENERGY SYSTEMS: WIND POWER

Alistair McCosh
ISS Institute/TAFE Fellowship

Fellowship funded by OTTE, Victorian Government

TABLE OF CONTENTS

1.0 ACKNOWLEDGMENTS

Fellowship Organisation:
The International Specialised Skills Institute Inc (ISS Institute)

Fellowship Sponsor:
Office of Employment, Training and Tertiary Education (OTTE)

Employer Support:
Mr Barrie Baker Director, Ms Julie Kean Associate Director Development,
South West Institute of TAFE

2.0 INTRODUCTION

2.1 International Specialised Skill Institute Inc. (ISS Institute)

The ISS Institute fills gaps in industries and enterprises where the means of doing so are not available through government programs of Australian TAFE institutes and universities.

ISS Institute:

- Explores opportunities in 'design' and skills (traditional and leading-edge) and identifies knowledge gaps towards establishing a range of collaborative projects with industry, professional associations, firms, education and training institutions and government.

- Identifies experts in diverse areas of design, master level trades and professional occupations in established and emerging industry sectors with the intent to effect their services to visit Victoria to conduct a range of education and training activities such as lectures and workshops.

This is achieved through the development of global partnerships with the fellowship program. The training and educational activities that stem from this ensures that the skills are continually being infused into the cookery environment and subsequently the Industry.

ISS Institute's operations are directed towards bringing knowledge and leading-edge technology to Australian Industry, business and education/training institutes. The loss of specialised skills and knowledge from the industry can be rebuilt to better enhance the capabilities of industry and business, maximising opportunities in the global and local marketplace and, now importantly through this fellowship the expansion into rural Australia.

The outcomes for such an intuitive organisation has meant the creation of many new business enterprises, the development of existing businesses in sustaining a competitive edge and the return of lost skills and knowledge to the workforce generating renewed interest and faith within the job market.

Since 1999, the Victorian Government, through OTTE, has financially supported ISS Institute, as its major sponsor.

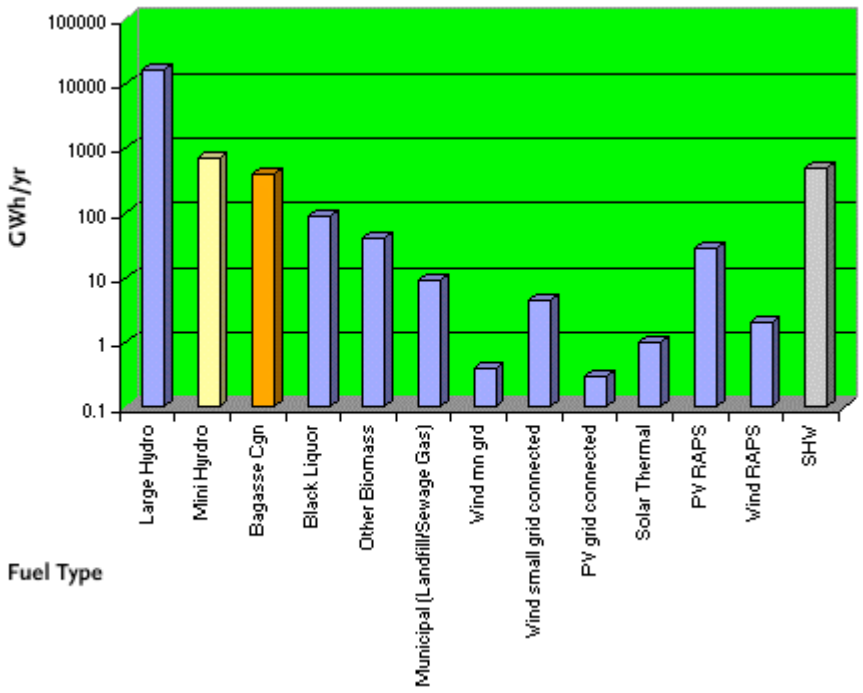
The ISS Institute was awarded to Alistair McCosh to undertake a program of study in the areas of alternative and renewable energy systems that would benefit rural Victoria and the Manufacturing Sectors that will be responsible for the establishment of the emerging renewable energy industry sector.

2.2 The Australian Context

The generation of electricity through renewable energy in Australia has to date been dominated by the large-scale hydro generation schemes, which have accounted for around 11 percent of renewable electricity production. The table below indicates the various forms of renewable energy electricity generated in 1997 which is the most recent data available. It clearly demonstrates that hydro is by far the greatest source of renewable power but it is provided to indicate that there is a significant number of renewable energy sources available for electricity production. This dominance is now being challenged by wind power as a viable cost effective renewable energy alternative. Wind power is now the fastest growing energy industry in the world with 10 year average annual growth rates estimated at over 24 percent. Looking specifically in Australia the market growth in the wind power industry the average growth has been 118 percent per year between 1999 and 2002 (Passey 2003)

With this increase in the wind energy industry the question of training for the sector must be considered. To date the need for industry specific skills has been minimal due to the industry being dominated by foreign companies that have imported a majority of the components that make up the wind farms. This however is changing as a number of foreign companies shift their operations to Australia and therefore require skilled staff that can manufacture, assemble and service all components that make up the wind energy systems.

The only training that has been required that relates directly to the wind energy systems have been in the metal fabrication. This training has been in a number of locations around Australia including Portland Victoria, Maryborough Queensland and Burnie Tasmania. At present their current training requirements can be met by the engineering training package.



2.3 Organisations that have an impact on this industry / occupation

Australian Business Council for Sustainable Energy (BCSE) - The Australian Business Council for Sustainable Energy (BCSE) represents the interests of the sustainable energy industry including renewable, cogeneration, gas-fired generation, and waste-to-energy and energy efficiency. The BCSE's lobbying activities are aimed at ensuring that policy measures are implemented to support these technologies to deliver a cleaner and more sustainable energy future for Australia

The Australian Cooperative Research Centre for Renewable Energy (ACRE) seeks to create an internationally competitive renewable energy industry. ACRE brings together excellent research capabilities and market knowledge into a world class centre for innovation and for the commercialisation of renewable energy systems.

Australian Federal Government- Responsible for the setting of the Mandatory Renewable Energy Target that will have an impact on the potential development of the renewable energy industry in Australia

Australian Greenhouse Office- The Australian Greenhouse Office (AGO) is the world's first government agency dedicated to cutting greenhouse gas emissions. It was established in 1998 as a separate agency within the environment portfolio to provide a whole of government approach to greenhouse matters.

Australian National Training Authority – responsible for the development of the national training packages

Australian Wind Energy Association - The AusWEA Australian Wind Energy Association's Vision is for a robust Australian Wind Community that makes a significant contribution to safe, reliable, economically and environmentally sustainable energy supply in Australia.

Alternative Technology Association- Established in 1980, the Alternative Technology Association (ATA) is a non-profit community group that aims to use and promote environmentally friendly technology.

Blue Wind Energy - An initiative of Pacific Hydro, Australia's leading renewable energy company, Blue Wind Energy expects to avoid 900,000 tonnes of greenhouse pollution a year by 2005 - equivalent to removing more than 200,000 cars from the road!

National Centre for Sustainability – The centre is a consortium of four individual institutions these being South West Institute of TAFE, Swinburne University of Technology TAFE Division, Sunraysia Institute of TAFE and the University of Ballarat TAFE Division The consortium identifies four strategic directions for the Centre – alternative energies, land and water management, corporate and community sustainability, and environmental design.

The Photovoltaics Special Research Centre was established at the University of New South Wales in 1990 with founding grants from the Australian Research Council and Pacific Power. The three objectives of the Centre are to incrementally improve the performance of present photovoltaic (solar cell) technology, reduce solar cell costs while maintaining high performance by, for example, developing thin films solar cell technology, and investigate photovoltaic applications and the supplementary hardware needed for these applications, including their associated technical, economic and environmental issues.

Sustainable Energy Authority of Victoria - The Sustainable Energy Authority was established in 2000 by the Victorian Government to provide a focus for sustainable energy in Victoria. Improving energy sustainability is part of the Government's commitment to sustainable development as outlined in the publication *Growing Victoria together*.

Sustainable Energy Development Authority – The Authority's mission is to deliver greenhouse gas reductions, environmental, economic and social benefits to the NSW community by accelerating the transition to sustainable production and use of energy.

2.4 The aim of the fellowship and its sponsors

The ISS Institute/TAFE Fellowship was sponsored by the Office of Employment, Training and Tertiary Education (OTTE)

2.5 Skills Gap

In looking at the skills gap the focus of this report is predominantly on those skills required for the emerging wind power manufacturing industry in Australia. The training sector will however need to address the skills gaps that will emerge when the other renewable energy alternatives such as photovoltaic, wave, geothermal and biomass become economically viable options for power production.

The skills gap in the wind power industry is the specific manufacturing competencies that are unique to the manufacturing of wind tower rotor blades and in the servicing of these power generation systems. These competencies include higher level research and development skills as well as the lower level manufacturing skills required in the making of blades. These include the tip end and root end manufacturing process and the finishing process of the blade.

The skills gap related to the maintenance of the Nacelle which is the generator that is located at the top of the wind tower will need to be addressed. This maintenance is currently being filled by staff who have relocated from overseas but as the number of wind farms increases in Australia their will be a definite need for locally trained staff.

In relation to future skills gaps for the other emerging renewable energy sectors these will be across all facets of these industries in the areas of research, design, manufacturing and servicing.

3.0 THE FELLOWSHIP PROGRAM

3.1 Introduction

Two objectives were identified that I wished to focus on through observation, discussion and participation and these are indicated below.

- To identify and research the current attitudes and emerging ideas within Europe and the United Kingdom towards renewable energy production encompassing perspectives from the industry, educational and government sectors as well as the general community.

- To take a particular focus on skills required in the manufacturing of rotor blades that are utilized in the generation of electricity through wind turbines. To ensure that the new innovative designs and manufacturing techniques that are being trailed in Europe are considered as the base skill set for the Australian wind power industry.

Prior to my departure I undertook extensive research into who were the key stakeholders in the renewable energy sector both within Europe and the United Kingdom. I was aware from my previous experiences in the early 1990's that Denmark was the leader in wind power and this was still the case in 2002 with several large companies who are world leaders in wind power technology having their head offices in Denmark. Germany was also on the itinerary as it has in the last five years seen the largest take up rate of wind energy.

England was also a destination in my fellowship for several reasons. One was to observe and participate in the manufacturing process at the NEG MICON blade processing plant in the Isle of Wight and to commence the development of a training program that would be the basis for a rotor blade training plan for the proposed manufacturing plant in Portland. Secondly, England is similar to Australia in realising that greenhouse gas abatement measures need to be addressed for obvious environmental reasons and to observe and discuss how they are endeavouring to achieve this objective.

I was able to arrange my visits through making direct contact with relevant industry and organisations via email and also through industry contacts that had been arranged through our partnership with NEG Micon.

I began my trip in London and then travelled to the Isle of Wight for one week. I then caught a flight to Germany and then Denmark. In each of the countries I visited I was able to visit industry, educational institutions and renewable energy associations. Another important contact I had was my talks with the general pubic when the opportunity presented itself whether it be on a plane in a restaurant or while sitting waiting for a train.

3.2 Educational Institutions/host organisations

British Wind Energy Association (BWEA) London UK

The purpose of this visit was to gain a perspective on the wind energy industry in Britain in terms of growth of wind as a viable energy alternative, what role has government played in moving the industry forward, what has been the community's attitude to wind farms and has there been a role for vocational education providers in servicing this emerging industry.

Nick Goodall the CEO of the BWEA was available to meet with me and he explained firstly how the wind energy industry in the UK had gone through three phases. He described these as phase I which was the initial excitement and enthusiasm that came with the commissioning and erection of the first wind farm which occurred in the early 1990's. The second phase was when this initial enthusiasm waned and the commissioning of new farms was very slow with little activity for the next five to seven years. The third phase which they are currently moving through is a significant push for wind farms by the government and supported by the BWEA and other environmental lobby groups as they realise that wind is part of the solution to Britain's power needs in the future and the obvious environmental economic and social benefits that flow from a strong wind energy industry.

In relation to the role played by vocational providers in the delivery of industry specific training for the wind industry the BWEA indicated that this role was minimal at this point in time. The reason for this was that the industry in terms of manufacturing had not been in operation for many years and that the training had been undertaken in house. There was an indication that through there own research that skilled staff in some areas of the manufacturing process was going to be an issue. This was due to some new industry being located in the regional areas of the country and sourcing appropriately skilled staff was a problem.

NEG Micon Rotors Isle of Wight UK

My visit to NEG Micon Rotors began with the compulsory company induction. This involved looking at briefly what was done at the manufacturing plant and outlined the Occupational Health and Safety issues that any one either visiting or working at the plant must be aware of and understand. The induction outlined a brief history of how the factory came to be located in the Isle of Wight and explained the significant growth that it had experienced since commencing operations in 2000.

Following this induction I was then given a tour of the facility and this allowed me to get a first hand look at the various processes that are involved in making rotor blades for wind turbines. The factory has two distinct areas these being the manufacturing area and the research and

design area. The company employees around 450 staff at the Isle of Wight site and also has a small manufacturing centre on the mainland in Southampton which is responsible for manufacturing the web supports that provides strength to the blade and also manufacture the moulds which the blade is made in.

NEG Micon Rotors Ltd St Cross Business Park Newport Isle of Wight UK

The next five days at the factory involved me working in all sections of the manufacturing part of the business both on the Isle of Wight and in Southampton. This was an excellent way in which to gain an understanding of the skills set that would be needed by staff that would need to be employed in the manufacturing plant that is proposed for Portland in Victoria. The work included assembling the major components of the blade including carbon slats, wood and various glass matting's. The work tasks are not difficult as there are clear work schedules that they need to follow but it is essential that they are accurate in where each component is put as the blade will not balance if they are out and the process will not proceed until all is in place. When all parts are in place the vacuum bagging process occurs which involves the pumping of resin into the mould and vacuum bag that covers the glass matting and various carbon and timber components. This is the most crucial part involved in the manufacturing of the blade as the chemical reactions that take place in the resin infusion process only have a certain window of time in which to ensure the process works.

I also worked in the finishing section of the plant which involves a number of tasks each with a specific skills set. The painting of the blade, the installation of the lightning strike hole, the sanding of any raised resin on the surface of the blade and the identification of any voids in the blade are all undertaken during this process. The blade is then put through a quality assurance checklist before it is given the final stamp to indicate it can be shipped out to the customer.

Techniker Schule Buztbach (Vocational Training School Germany)

The Butzbach Technicians School is located in Butzbach, an old town in the centre of Germany, 50 kilometres north of Frankfurt. I was welcomed to the school by the Head of Centre Diethardt Stamm who was responsible for the Environmental technicians training program and was the driving force behind their purpose built energy efficient building that is used as a classroom for the various programs run at the centre.

ButzbachTechnical School Energy Efficient Building

The school for technicians offers two year fulltime classes for people who have already done an apprenticeship and want further education. Students can choose between three different courses with the focus of my visit the environmental technicians program.

The school for environmental technicians (Fachschule für Umweltschutz- technik) is organized as a two year fulltime course that qualifies students as government approved technicians (Staatlich geprüfter Techniker).

The student who completes the two year program is qualified to make energy balances of buildings and products, can consult and cooperate on energy concepts of buildings, is able to advise customers about possibilities of energy saving and use software for planning energy plants and for making energy balances.

In 1995 the school was selected as one of twelve ecologically orientated schools by the Hessian minister of education and arts. Euro-Solar presented the European Solar Award to the school in 1997.

Apart from looking around the complex I was able to discuss what role they played in training people in the wind power industry which employed a considerable number of people in the region around Butzbach. The response was very little training as they required all students to come to the school to undertake training. The idea that the school would go out and deliver a flexible training program like we do in Australia with our onsite industry training was not considered an option. There was some minimal consultancy that the school had undertaken with industry looking specifically at how to measure wind speed in areas around the region but that was the total off campus activity with industry.

Fuhrlander (Friendly Energy) Fuhrlander Aktiengesellschaft Auf der Hohe 4 Germany

This company is a manufacturer of Wind Energy Systems that has contracts around the globe. This visit was not planned on my itinerary but became possible following my visit to the Butzbach Technician School. I was given a tour of the facility and given time to talk about the wind industry and other topics by Dr Jan Ross Project Manager at the company. It was interesting to visit another wind power company that was responsible for a large number of different wind farms around the globe. The company is different to NEG Micon the other company that I had visited in that it does not manufacture any of the components that make up a wind turbine but buys all of them in from other companies and assembles them to the client's specifications. The company also provides after sales service to all its customers and had established several service divisions in other countries through out the globe.

One innovative development that the company has an international patent for is the combination of wind power plus reversed osmosis. This groundbreaking research has the potential to provide drinking water to areas on earth that have previously not been able to access water by using wind power.

In relation to the issue of training at this company all of it was done on the job by the company's own in house trainers. It was pointed out by Dr Ross that a majority of staff who were employed had undertaken some form of accredited training in the mechanical and electrical engineering areas.

In a broader discussion with Dr Ross about the reasons why there had been such a significant increase in wind power in Germany over the previous five years he suggested that it could be attributed in large part to the German government. This support has seen a number of acts passed as law which ensures that electricity generated through renewable energy increase significantly by 2010. One law for example that has been adopted introduces minimum prices for feeding into the electricity grid one way in which to make the industry viable.

Installation of a generator on one of the Fuhrlander Wind Turbines www.fuhrlaender.de

AMUSYD Ribe Afdeling Snepsgardevej 20 6760 Ribe DENMARK

AMUSYD is a vocational training provider that is located in the southern part of Denmark outside a small regional centre named Ribe. When arriving at the centre it reminded me to a certain degree of the campus that I come from in Portland Victoria in relation to size. My contact for the day was Mr Jens Johansen who is responsible for the training in the Plastic Polymer area. The AMU is responsible for all the training in Denmark that is required by the wind power industry in terms of Epoxy and Polyester based products. The training is conducted both onsite and also out in industry and is a lot closer to matching the models of delivery that we have in Australia.

In relation to training specific to the rotor blade industry the institute has developed specific courses that are tailored to the two blade manufacturers that they service. The two courses are in Epoxy based composites and the other is in Polyester based products. The courses are 25 days in duration and when participants have completed their program they go straight into the factory to commence manufacturing of the rotor blades.

The tour of the facilities followed and it then became apparent to me that AMUSYD was involved in this training in a major way. The investment in terms of the latest equipment and the amount of resources was significant and included training for all industries involved in the plastics and resin based manufacturing sector. I asked Jens what role the government has played in funding the centre and ensuring it remained at the forefront in the manufacturing techniques used in industry. His response was that it provides 90 percent of the funding for the centre with industry contributions and student fees making up the remaining 10 percent. This ratio was changing however as commercial activity was being encouraged to support the costs of running the programs.

The centre also provided onsite accommodation for the participants of the training programs if they were required to travel any further than 50 kilometres and this was also subsidised by the government. The facilities where not only utilised by the participants involved in the plastics and polymer training but various other industry based programs offered by the centre.

The visit provided the first real opportunity to see a training program that catered for the rotor blade manufacturing industry and the openness and information offered by Jen's was excellent. It gave me a some clear direction as to what is the standard of training offered by a training provider who is delivering a program that industry both recognises as the level required for entry level trainees which will be the trainees we will be delivering to at our Portland campus. The visit also provided me with some confidence that program format that I had been starting to formulate in conjunction with the training staff from NEG-Micon was moving in the write direction and that we now had a clear bench mark in which to strive towards in relation to program delivery.

Front entrance to the AMUSYD centre.

LM Glasfiber A/S Rolles Mollevej 1, DK 6640 Lunderskov

The opportunity to visit LM Glasfiber in Lunderskov in south east Denmark was a great plus to my overall fellowship as LM Glasfiber are the world leaders in rotor blade manufacturing and design. My contact at LM was the Business Development Manager Mr Troels Thomsen. The meeting commenced with Troel's providing an overview of the history of LM and how it had come to be the largest supplier of rotor blades. The LM Glasfiber Group traces its origins back to 1940 when Aage Skouboe founded Lunderskov Møbelfabrik to produce wooden furniture. In the early 1950s, Lunderskov Møbelfabrik began exploring the commercial application and uses of fibreglass technologies and subsequently changed its name to LM Glasfiber. At the beginning of 2002 the company had manufactured 60000 blades and had factories located in Denmark, Spain, the USA, India and China. It employees over 3000 people and moved into rotor blade design and manufacturing in 1978. In relation to the training of manufacturing staff this is conducted by the AMUSYD which I outlined above. They also requested other individual training courses for staff which included forklift training or manual handling refreshers and this was done on an as need basis.

Following this introduction I was given the opportunity to take a tour of the facilities at the Lunderskov facilities which covered two sites which included manufacturing, design and administration functions. It was interesting to compare the manufacturing centres and processes to the NEG Micon facilities in the UK. The house keeping requirements in terms of everything in the plant having a place was paramount in the Denmark with no waste materials in view; each worker was also required to sign off on each work instruction related to the manufacturing process for the particular blade they were working on. In contrast the UK plant was far more cluttered with materials and this can be attributed in part to the blades made by NEG Micon consisting of timber and carbon components with the LM blades being made entirely of composite materials. Another reason for the differences is that LM has a much longer history in making blades compared to NEG Micon which is still refining their processes which includes the training of staff in the correct manufacturing processes including good house keeping skills.

A LM Glasfiber blade coming from the factory

The Lunderskov site in Denmark www.lm.dk

LM Glasfiber A/S Rolles Mollevej 1, DK 6640 Lunderskov (Continued)

The tour of the plant also provided an opportunity to have a look at the research and testing facilities that are crucial to LM Glasfiber remaining at the forefront of rotor blade design. The company invests millions of dollars each year in both new research and development and in continuing testing of the blades that are manufactured. The research is extensive in both the design of the blade in an endeavour to strive for optimum energy output to research on materials and processes. Troel's in our visit to this part of the facility indicated that the research and development is carried out in close collaboration with a number of international universities and technology institutes. It also highlighted to me that this is an area of research and design that Institutes and Universities in Australia need to consider getting involved in as Australia's wind conditions and locations may require a different product to ensure maximum output from the wind power generator.

The LM Glasfiber Rotor Blade testing facility at Lunderskov Denmark www.lm.dk

Folkecentre for Renewable Energy DK- 7760 Hurup Thy Denmark

The Folkecenter for Renewable Energy is an independent, non-governmental organization. It was established in 1983 to pave the way for renewable energy by developing, testing, and demonstrating technologies which are designed for manufacturing in small and medium scale industries. I was welcomed to the centre by Jane Kruse who is responsible for information and training and who gave me a brief history on the centre. We then had lunch and where joined by the director of the centre Preben Maegaard who has an international reputation as a leader in the area of renewable energy.

The discussion over lunch provided me with an opportunity to ask a whole range of questions about where renewable energy sits in relation to the future of energy production in Europe. The response was both positive and negative depending on which country you were discussing. Denmark for example a leader in the take up of renewable energy in the past fifteen years has stalled in increasing the level of renewable energy electricity used due to a change in government in 2001 and its decision to reverse the policy that ensured minimum prices for feeding into the grid electricity generated from renewable energy sources.

Germany in contrast continues to be the leader in all areas associated with the adoption of renewable energy as a form of electricity generation. With the purpose of protecting the environment, managing global warming and securing a reliable energy supply, the German Government and the German Budestag committed themselves to at least doubling the percentage share of renewable energy in total energy supply by the year 2010 (Maegaard 2002)

Folkecentre for Renewable Energy - Denmark

NEG Micon – Ribe Denmark

The visit to the head office of NEG Micon in Denmark provided an opportunity to see the other side of the company which I had visited in the Isle of Wight. The Denmark site is responsible for the overall operations of the company including research and administration. It is also the location for the manufacturing of the Nacelle which is the generator that sits on top of the tower. I was fortunate to be given the tour of the facility by the manager of the training division. This division which has a fulltime staff of five trainers and two administration staff are responsible for training staff across all areas of the company and can be called onto deliver training anywhere in the world that the company operates in.

The division has only been in operation for two years and was formed as a result of the rapid growth of the company and a need to ensure that there was a consistency within NEG Micon staff in relation to skill base. The division is primarily focused on training staff who will be service agents for the NEG Micon wind farms that are purchased by customers around the globe. This training is delivered on site and requires that the team take all equipment needed to conduct the particular training needed for each site. This consists of over a tone of equipment.

The trainers with exception to the manager are all staff who have worked in various divisions within the company and who have the technical expertise and experience of the NEG Micon product range. It was this background that the manager of the training department sort out to assemble the training division. He felt that it was far more important to have that technical expertise and train them on the skills required to deliver a training program than visa versa bringing in professional trainers who then gain the technical expertise. This approach is similar to what we do here in Australia in many of the vocational programs we conduct and has proved to be a most successful model for delivering industry specific training programs.

The visit proved very beneficial for a number of reasons. One it highlighted to me once again that the wind energy industry is a major industry that is continuing to grow at a phenomenal pace, NEG Micon Denmark has for instance have two full time staff dedicated to arranging flights and accommodation for staff who travel the globe working on projects this gives you some indication that they are a considerable business. Secondly the training that their training division was conducting was training that I am confident can be delivered and improved on by Australian vocational training staff once provided with the necessary experience and exposure to the technology that is the wind energy industry.

3.4 Outcomes of the Fellowship program

Customisation of Training Packages

The fellowship has provided the opportunity to understand what is needed in relation to the training requirements for the manufacturing of the rotor blades for the expanding wind energy industry. It has highlighted that the skills gaps are not significant and that with some customisation to the current curriculum from the Australian Plastics Training Package the training required by the emerging rotor blade manufacturing industry could be met.

This customisation would involve a number of competencies, which would replace general directions with enterprise specific needs in the training package. There would also be a need to replace generic equipment/process names with enterprise specifics needs and a replacing of general processes/specifications with enterprise specific needs.

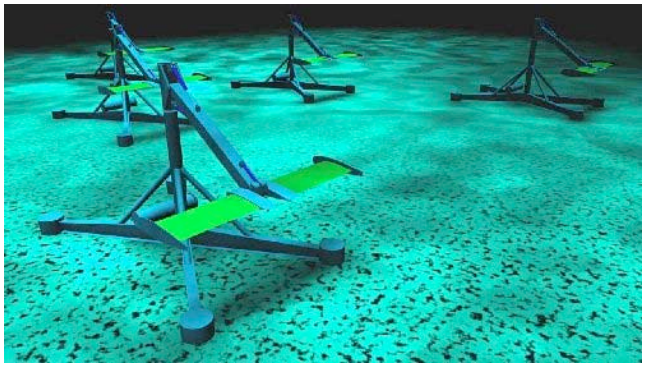
Solar Power

Other skills gaps that will emerge in the next five to ten years in the area of alternative energy systems within the Australian industry sector will be the increased utilisation of solar (photovoltaic) power systems. The skill gaps will be predominantly in the installation and maintenance of these systems as Australia is a world leader in the manufacturing of solar cells through BP Solar. The growth in the industry will occur when industry, government and the public recognise the advantages that can come from the installation of solar systems and they become more economically competitive with existing power systems.

Looking specifically at the United Kingdom thousands of homes and offices across the UK are set to be powered by cleaner energy as part of a £20m solar power programme approved in March 2002. The money is being made available through the Department of Trade and Industry Major Photovoltaic Demonstration Programme and will help reduce carbon emissions and significantly cut the cost of solar technology over the next three years. Grants will be offered to the private and public sector to install solar systems on new or existing buildings. As a result of this investment, the number of domestic solar power - or photovoltaic - installations in the UK is expected to increase ten fold by 2005.

Wave and Tidal Power

Through my fellowship two other industry areas that need to be monitored closely that I believe will emerge in the next decade will be those of tidal and wave power. Tidal energy exploits the natural rise and fall of coastal tidal waters caused principally by the interaction of the gravitational fields of the earth-moon-sun system. Ocean tides, which result from this interaction, produce variations in ocean water levels along the shores of all continents. As the water level fluctuates twice daily through this range, it alternatively fills and empties natural basins along the shoreline, suggesting that the currents flowing in and out of these basins could be used to drive water turbines connected to generators and thus to produce electricity. There are a number of research and development projects being undertaken in the United Kingdom that have shown through various trials that the potential is there for tidal power to be a commercially feasible option for power generation.



A future tidal wave generator
www.engb.com

Wave energy is a concentrated form of solar energy. Ocean waves are created by the interaction of wind with the surface of the sea. The energy contained in ocean waves can potentially provide an unlimited source of renewable energy. Wave energy converters extract and convert this energy into a useful form - usually electricity - although wave energy converters could also be used for water desalination. They can be deployed either on the shoreline or in the deeper waters offshore.

Currently there is no renewable energy being generated from wave power in Australia, although there are wave demonstration plants in Port Kembla (NSW) and Portland (Victoria). There is however a major development that has been announced in June 2003 that will see the research and development of a dual-purpose energy generator that is about to enter prototype testing stage. The companies involved are Pacific Hydro Limited, Carnegie Corporation and Seapower Ltd and the project has been provided with an R&D Start grant from AusIndustry to assist in the commercialisation of the technology. It is when commercialisation of the technology is achieved that the issue of skills gaps occurs as full scale manufacturing requires staff that have the technical and practical skills-set to produce the product. There will also be the need to have trained service and maintenance technicians who can ensure the ongoing operation of such systems.

Pictured below is 500kw Turbo Wave Generator that has been manufactured in Scotland. The picture highlights the size of the generator, which would require trained staff who has skills in engineering in the areas of fabrication, mechanical and electrical to produce such a product with obvious industry specific training needed to manufacture such a product

Engineering Skills Shortage

Looking at skills outside of the vocational area but are at the higher level is that of engineers who are involved specifically in the research, design and testing of new alternative energy systems. From my visits to companies one of the largest departments was that of the design, development and research, which employed many graduate and experienced engineers to work on improving current systems and research and develop new designs for the new systems that customers were requesting, be produced.

In looking at the current engineering degrees that are offered through tertiary educational institutions in Australia there would appear to be no courses that have any specific focus on engineering within the alternative energy area. This will result in a skill shortage in the engineering sector for the emerging industries that are being set up Australia and will require the need to recruit into Australia appropriately trained engineers who have these skills sets and who can administer other engineers who may cross over from other more traditional engineering sectors.

Auxiliary Skills

Other skills gaps that will emerge as the renewable energy sector expands will be the skills and knowledge needed to conduct assessments of resource capacity, design of wind and wave farms, noise assessments and the legal and financial knowledge needed in funding such developments.

4.0 RECOMMENDATIONS

Economic Opportunities

Australia has the opportunity, ability, expertise and environmental capacity to be a major player in the generation of alternative energy through the embracing of renewable energy technologies. These opportunities cannot be measured purely in economic terms but also include the significant benefits from an environmental perspective.

The economic benefits have been highlighted throughout the report; in summary they will be both from direct and indirect jobs that will be generated by the establishment of the renewable energy sector. The direct jobs will be in various areas including manufacturing, engineering both mechanical, environmental and electrical. It will also include work in the legal, construction and research areas and has the potential to be a significant export market. In relation to the indirect job creation empirical evidence from the Danish market suggests that from every direct job created, 4.1 indirect jobs are created. (Sinclair Knight Merz, 2001)

Other economic benefits would be that created by rental returns to farmers who provide land for wind towers to be erected. The Australian Wind Energy Association has indicated that if 5 percent of a 10 percent renewable energy target were met by wind then farmers would be in receipt of 17 million dollars by 2010. Wind power is also a boost to regional tourism with surveys indicating that more than 100,000 people per year are already being attracted to see wind farms in Australia (Passey 2003)

Environmental Opportunities

The environmental opportunities that will come from the adoption of renewable energy as a means for electricity generation are significant. One example of what can be achieved by adopting renewable energy has been at the Queen Victoria Market. Seventeen hundred square metres of photovoltaic solar panels were installed on the roofs of sheds C, D and E of the markets as their orientation and pitch are ideal for solar panels, giving maximum output and minimizing installation costs. These panels will produce 250 megawatt hours of electricity a year, the equivalent to the average electricity consumption of over 60 houses. The building was previously using an estimated 900 megawatt hours per annum of conventional electricity.

The installation will save more than 378 tonnes of greenhouse gas emissions each year; (based on Australian Greenhouse Office estimations that in Victoria, every kilowatt-hour of electricity generated by clean energy sources - sun, wind and water - abates an equivalent of 1.467 kilograms of greenhouse gases. (www.melbourne.vic.gov.au)

Further examples of the environmental benefits to be gained from renewable energy generation are for example those that will be gained from the Portland Wind Farm. The project will produce enough pollution free electricity for 100,000 homes which is sufficient to supply a city the size of Geelong this will result in the greenhouse gas abatement of equivalent to 680,000 tonnes of greenhouse gases being released into the atmosphere.

From these two examples it is clear that the utilisation of renewable energy has the capacity to provide a clean green source of electricity without the negative impact of greenhouse gases being produced.

ISS Institute Inc

The ISS Institute aside from the role it plays in the facilitation of the fellowships with the selection process and in the support it provides for each of the fellows prior to departure needs to also be involved in assisting in the dissemination of findings from each of the fellowships. In relation to my own findings I would see that the ISS Institute can play an integral part in helping bring together various stakeholders from industry, business and government who may benefit from what I have learnt and experienced from my fellowship.

One example is that this assistance can be through the support and advice in the development of a conference program being considered in 2004 which would be targeted at Environmental Sustainability within TAFE with one of the key themes of the conference being the renewable energy sector.

4.2 SOLUTIONS

Awareness

If the renewable energy industry is to be the next "revolution" like the agricultural and industrial that has preceded it, there is a need to ensure that the general public, government and the decision makers in business and industry truly understand the real capacity the sector has to address our growing energy needs along with the environmental, economic and social benefits that has been identified earlier in the report. The capacity is reflected in a statement made by Dr Hermann Scheer General Chairman of the World Council for Renewable Energy and the winner of the Alternative Nobel Prize in 1999

> *The natural potential of Renewable Energies that is available on earth every day is 20,000 times larger than the daily consumption of atomic and fossil energies. Renewable Energies are inexhaustible. The technical potential has also been developed so far until today that more energy could be converted than humankind would need. Since these technologies are still relatively young, there is an enormous potential of further technological improvement and new applications. Due to further technical developments, industrial production and multiplied experiences in the use of these technologies within the near future, the certain economic prognosis is that continuous cost degressions will occur*. (Scheer, H 2002)

Increasing awareness of this recognised potential will be a major challenge but it will occur as leaders within industry, business, government and our educational institutions recognise the importance of embracing renewable energy and hence use their positions within society to influence change.

A Proactive Approach

One underlying theme that became apparent in my travels through Europe was the integral role of government in any advancement of the renewable energy sector. Those governments that have adopted policy that has provided a more competitive playing field for the emerging renewable energy industries stand to profit both economically, socially and environmentally both now and well into the future.

Preben Maegarrd a leading European researcher and academic in the area of renewable energy states that with "government support the increased use of renewable energy will create jobs, especially in the sector of small and medium-sized enterprises. They play a crucial role in the economic structure of most European countries. Small and medium-sized enterprises are not only an important factor in crafts and trades; they also provide an impetus for a variety of industries, including the metal industry, electrical engineering, mechanical engineering, biochemistry, as well as the building industry (Maegarrd 2002)."

The Germany, Denmark and Spanish governments have all legislated towards ensuring tariffs and feed in costs related to grid access have been set at a rate that ensures that commercialisation of renewable energy projects is achievable. It is this forward thinking and strong leadership that we will need both from the Federal and State governments in Australia for the renewable energy industry to have any chance of succeeding in a market dominated by the traditional fossil fuel generators.

It should be noted that there has been positive moves by both state and federal governments which have included mandatory renewable energy targets (MRET) and this has led to the commitment by a number of renewable energy industries to invest in manufacturing and research. The key though is for governments to ensure that the targets set provide the incentives for industry to continue this investment.

This was reflected in the findings from a report presented to the Hon Ian McFarlane Minister for Industry, Tourism and Resources by the Renewable Energy Action Agenda CEO Group. It stated

> *There are many within the renewable energy industries that have called for the MRET to be significantly increased, in order to further stimulate industry development. The long term nature and high perceived risk of the innovation process, together with the prospects for substantial domestic and international trade benefits to be derived from Australian developments in certain areas of renewable energy, provide the rationale for a greater degree of Government intervention to gather and maintain the momentum in establishing this emerging industry.*

The ISS Fellowship has also provided the opportunity to initiate discussions around what role the vocational education system may have in the emerging industries that are driven by renewable energy systems. These discussions will continue through various forums for example the planned conference in 2004 and through the training programs that will be developed to service these industry sectors.

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