JOBS AND INVESTMENT POTENTIAL OF RENEWABLE ENERGY: AUSTRALIAN WIND INDUSTRY SCENARIOS

I.F. MacGill and M.E. Watt*
School of Electrical Engineering and Telecommunications
*ACRE and the Centre for Photovoltaics Engineering
University of New South Wales
Sydney, NSW 2052
AUSTRALIA
Telephone: +61 02 9385 4920
Facsimile: +61 02 9385 5993
E-mail: i.macgill@unsw.edu.au

Abstract

Along with the environmental, energy security and poverty concerns driving the rapid growth of renewable energy worldwide, there is an increasing recognition of the investment and job creation opportunities arising from this growth. Here we present some findings of an Australian CRC for Renewable Energy (ACRE) study into the development and employment potential of the Australian renewables industry. We focus here on the promising Australian grid-connected wind generation sector. A brief review of international experience and the Australian industry's current status provides a range of possible wind growth scenarios to 2010. Our estimates of the possible economic and job outcomes for these scenarios support the case for strong policy support to this industry.

1 INTRODUCTION

The renewable energy industry worldwide is experiencing rapid growth. The drivers for this include increasing environmental and energy security concerns with fossil fuels, the falling costs of many renewables and greater appreciation of the needs of the roughly two billion people in the developing world who don't yet have access to commercial power (IEA, 1999). The economic development and job creation potential of renewable technologies are also increasingly recognized as important reasons for supporting the industry's growth, and form the focus of this paper.

Wind power is proving one of the great renewable energy success stories. It is the fastest growing energy source in the world, with installed capacity growing at an average 40% annually over the last five years (EWEA, 2002). Installed capacity at end 2001 was almost 25,000 MW. Industry turnover in 2001 is estimated at more than US$5 billion and perhaps as high as US$8 billion (Gipe, 2002). The wind industry worldwide now provides some 70,000 direct jobs.

The potential for the global wind industry to continue this growth is apparent. One forecast is for annual installations to grow to over 14,000 MW by 2006 with wind supplying 2% of the world's electricity by the end of the decade (Gipe, 2002). Much of this growth will be driven by increasing international efforts to combat climate change, and support renewable energy based generation. In many countries, wind is proving one of the most appropriate and cost effective renewables options to meet such renewables targets (EWEA, 2002).

This paper presents some findings of an Australian CRC for Renewable Energy (ACRE) study that explores the employment and economic development opportunities within the Australian renewable energy industry. The first stage of this work was developing case studies of a number of recent bioenergy and wind generation projects in Australia (MacGill, 2002a). The second stage of this study has been to explore some selected Australian renewable technology sectors, estimating possible economic growth and job outcomes for a range of industry growth scenarios (MacGill, 2002b). Here, we present scenarios for the promising Australian grid-connected wind energy industry.[1]

Section 2 briefly surveys the Australian wind industry's present status and prospects. A number of possible industry growth scenarios are outlined in Section 3 and the analysis methodology is described in Section 4. The outcomes of this scenario analysis are presented in Section 5.

[1] Australia has a viable and established industry manufacturing small wind generators in the KW range for domestic and export markets (AusWEA, 2002). The focus in this paper, however, is on large grid-connected wind projects.

2 AUSTRALIAN WIND INDUSTRY STATUS AND PROSPECTS

At the end of 2001 Australia had approximately 69MW of grid-connected wind generation. The Windy Hill and Blayney developments completed in 2000 were joined by the larger (tens of megawatts) Codrington and Albany projects. For 2002, the Toora and Woolnorth Stage I projects are scheduled for completion – giving a total of around 100MW installed. These projects represent an estimated total A$190-210 million investment with perhaps A$85-95 million spent in Australia. Installation, some local supply of components and 20 years of O&M may see a total of some 750-850 jobyears of Australian employment.[2]

Recent developments include a confirmed start for the 80MW Lake Bonney project (Adelaide Advertiser, 2002) and conditional Victorian government approval for the 150-200 MW Portland Wind Project, based around local turbine manufacturing (Pacific Hydro, 2002). Hydro Tasmania has ordered 128 megawatts of Vestas wind turbines and confirmed the 54MW second stage of their Woolnorth project. Vestas have committed to Tasmanian assembly of the turbine nacelles and manufacture of fibreglass components (Hydro Tasmania, 2002).

The Australian wind industry shows considerable promise for the coming decade. The wind resource, particularly in Southern Australia is excellent by international standards, and potentially very large. The main factor will be Australian policy measures to support renewable energy. The nationally accredited Greenpower Scheme and various State Government initiatives have been influential in activity to date. Now, however, the major potential driver of industry development is the Federal Government Mandatory Renewable Energy Target (MRET) of an additional 9500GWh of renewable electricity generation in Australia by 2010 from 1997 levels.

Redding (2002) estimates that wind generation could be expected to contribute just over 30% of the current MRET target and projected Greenpower requirements that total 10,500 GWh by 2010. This would represent some 1000 MW of installed wind capacity. Recent concerns with the integrity of MRET with respect to pre-existing hydro might, however, see this considerably reduced (AEA, 2002).

There is growing support for increasing the nominally +2% MRET target given present trends in Australian electricity consumption, industry development opportunities and growing international action on climate change. Many countries are setting significantly higher renewable energy targets than Australia - for example, Germany has a 10% target for renewables by 2010 with 24,000 MW of wind and the UK a 10% target with 6% of this from wind (Harding, 2002).

It has been estimated that a +5% MRET target could see installation of over 3000MW of wind generation by 2010 (AEA, 2001). The Australian Wind Energy Association (AusWEA) has joined with Greenpeace (2001) in calling for a target of 5000MW of wind power in Australia by 2010 – broadly equivalent to perhaps a +10% MRET target.

3 WIND SCENARIOS

Given the above, we have chosen three Australian wind industry growth scenarios on which to base our economic development and job creation estimates, as shown in Table 1.

Table 1. Australian wind industry development scenarios for 2010

Scenario	Aust. Wind capacity in 2010 (MW)	Comments
Low	1000[3]	Existing MRET and projected Greenpower requirement subject to 'baseline' correction
Medium	3000	Approximate +5% MRET target
High	5000	AusWEA and Greenpeace target, roughly equivalent to perhaps a +10% MRET target

All of these scenarios require significant industry growth from its present status – the *medium* and *high* scenarios require very high average annual growth rates (over 50% and 60% respectively). This is not unachievable - the present

[2] Total investment is estimated using a figure of $1.9-2.1m/MW typical of these projects with Australian content assumed to average 45%. Employment estimates are based on (MacGill, 2002a).

[3] Given MRET's time horizons and the project financing advantages of early project implementation, this scenario assumes that all capacity is installed by end 2007.

industry here is at a very early stage of development and one large new wind project could effectively double Australian installed capacity. The need for strong and consistent policy to support wind development is, however, very clear.

Our objective for each of these scenarios is to make estimates of the possible Australian economic development and job creation outcomes that might arise from such wind industry development to 2010, as shown in Table 2.

Table 2. Economic development and job creation outcomes from scenarios

Outcome	Units	Comments
Capital Investment	A$ millions (2001 dollars)	Total expenditure to develop this installed capacity including equipment and construction
Aust. investment component	A$ millions	Amount of this capital investment spent in Aust.
O&M expenditure	A$ millions	Total expenditure on Operations and Maintenance of installed wind capacity
Aust. Manufacturing & construction jobs	Jobyears	Total direct Aust. jobs created by local manuf-acture of wind turbine equipment + installation
Aust. O&M jobs	Jobs	Total direct Aust. ongoing jobs for O&M of installed capacity

4 METHODOLOGY

There are numerous challenges for studies attempting to assess the economic and employment outcomes of particular industry sectors (MacGill, 2002a). These challenges are magnified in the case of the wind generation sector by its relative youth (with little publicly available data) and rapid growth over the last decade. Making such estimates for scenarios of future wind industry development is more problematic again given that industry's rapid international transformation in technology and scale. Some of the key issues are outlined below, along with our chosen strategies for managing the many approximations and assumptions required.

Capital costs: The capital costs of wind farms can vary markedly with factors including project scale, site accessibility, turbine technology, finance arrangements and grid connection requirements. The treatment of tax, grid connection costs and finance add to the challenge of accurate and comparable project investment estimates.

The capital costs of wind generation continue to fall – some 20% over the last five years with projected installed costs falling a further 30% by 2010 (EWEA, 2002). One key factor appears to be growing machine sizes – multi-megawatt machines are now on the market. Another factor is the move to larger wind projects in many countries (REPP, 2001).

Future costs here in Australia will depend on global trends, project size, local market growth with associated local economies of scale and the extent of local manufacturing. It can be expected that Australia will largely use equivalent machines to those on the international market. In line with world trends, currently proposed Australian projects are also becoming larger, an average 70MW for the 27 planned projects described by AusWEA (2002).

Australian content: The relative costs of the various components and associated activities in developing a wind farm can vary markedly. An approximate cost breakdown is 50% for the turbine, rotor and associated components, 15% for the tower with the remainder spent on site preparation, installation and project development (DWIA, 2002). Estimating the Australian component of total investment requires some significant approximations and assumptions. Grid-connected wind farms in Australia to date have utilised largely imported machines and components other than the towers and electrical interconnection equipment. Nevertheless, with a focus on local sourcing where possible, recent projects have achieved estimated Australian content (by value) of 44-50%[4] of capital costs.

The key driver of future Australian content is the establishment of local Australian manufacturing. Pacific Hydro (SKM, 2001) proposes to establish local manufacturing as part of its 120 wind turbine Portland project, and estimates it can achieve 90% local content. Vestas (2002) has outlined local manufacturing options for its 1.75MW machine including nacelles, towers, blades, specialised components and controllers that can achieve 95% local content by value.

[4] The Albany project had estimated 44% Australian content (MacGill et al., 2002) while the Toora project has achieved near 50% (Stanwell, 2002)

The advantages of local manufacturing include lower prices on the machines, faster and cheaper O&M services and reduced delivery lead times. The key to its establishment and, in particular, achieving a number of local players, is sufficient market size. For example, Vestas (2002) suggests a minimum 650MW production over five years for establishing a 'Greenfield' nacelle assembly plant, with even greater production levels required for local blade manufacture. With significant Australian market growth, one can envisage a number of Australian states developing local manufacturing capabilities.

Estimating the proportion of capital investment that is spent in the region of wind projects is difficult and highly project dependent. Much of the site preparation and construction can be sourced from local businesses. Some projects, like the proposed Portland development, have sought additional local benefits through plans for local manufacture – in this case some 27% of investment is slated for the Portland region, and 70% in the state of Victoria (SKM, 2001).

Manufacturing and installation jobs: Estimating the direct jobs created in the manufacture and installation of wind projects here is difficult and subject to numerous uncertainties as discussed in MacGill *et al.* (2002a). International and Australian studies to date have used a range of different definitions, approximations and assumptions leading to a wide range of estimates. Earlier studies are also of limited value given the rapid progress of the industry, including larger machine sizes, over the last five years worldwide. Nevertheless, estimates normally lie somewhere between three and eight total jobyears per MW installed, with many studies suggesting 6 to 8 jobyears (MacGill, 2002b).

It can be expected that most direct installation and construction employment requirements will be sourced regionally. Manufacturing employment breakdown for the different components does not precisely follow the cost breakdowns above due to different labour intensities for tasks such as towers and blades. Nevertheless, a rough approximation of where employment will be generated can be derived from where capital expenditure occurs.

It is widely expected that there will be a reduction in manufacturing and installation employment with industry growth and development including larger machine and project sizes. One approach for modelling this is to have employment per MW of new capacity fall in line with the decline in capital costs of wind power over time (EWEA, 2002).

Ongoing O&M jobs and expenditure: Studies estimating ongoing O&M jobs show considerably less variation than seen for manufacturing and installation. Estimates vary from 0.08 to 0.225 ongoing jobs per MW installed (MacGill, 2002b). A typical 20 year life for installed wind projects would see perhaps a total of two O&M jobyears per MW – a little less than one third of the total jobyears in manufacturing and installation. Nearly all O&M jobs will be filled locally. Again, it is widely expected that O&M employment per MW will fall with the coming larger more reliable machines and bigger projects.

O&M requirements for wind generation vary with factors including the type, duty regime and age of the equipment. More recent equipment is showing far greater reliability than many of the earlier machine types, and this fall in O&M requirements may be expected to continue. Estimates of ongoing O&M expenditure for installed wind capacity vary around the range of 1% of total capital installed costs each year (DWIA, 2002). A high proportion of this will be spent locally. This expenditure is low in comparison to the capital investment for wind generation, equalling around 20% of capital expenditure over the typical twenty year life of installed projects.

Given the above considerations, our chosen investment and employment indicator values for year 2002 and their evolution out to 2010 are given in Table 3. Given falling costs and employment per MW of new wind capacity over the decade, one key issue in our scenario analysis is how installation of this wind capacity is spread over the 8 years to 2010. Factors include the small scale of the existing industry, present planned projects and possible lead-time requirements on up scaling local manufacturing capability.

The compound growth rate used in many studies will not capture the large capacity increment that a single large project with local manufacturing could bring to the industry here. These scenarios utilise, instead, a steady increment in *new* wind manufacturing and installation capacity each year over the time horizon. This accords with the idea of additional manufacturing capacity coming on line each year adding to the existing production capacity of the industry.

Another question of great importance for the future of the Australian wind industry is the potential to leverage off a strong domestic market in order to export equipment and services to other countries in our region. This has not been explicitly included within the scenarios but suggests that even greater Australian economic and job outcomes can be achieved with strong policy support for a vibrant domestic wind market.

Table 3. Scenario indicators and their evolution over 2002 to 2010

Investment & job outcomes	New typical 20MW project	Indicator value for 2002	Indicator value's evolution to 2010
Capital investment	A$36-40m	$1.8m /MW	Reduction at 5% annually to $1.2m/MW in 2010 – an overall 33% reduction.
Australian content (by value)	40-50%	50%	Linear increase to 90% by 2008 then steady for the 3000 & 5000MW scenarios.
Australian capital investment	$16-18m	$0.9m /MW	Reflects falling MW costs yet increasing Aust. content giving $1.1m/MW for installations in 2010
Total jobyears for manufacture + installation	150-200	7.5 jobyears /MW	Reduced at 5% annually as for capital costs to 5jobyears/MW in 2010 – an overall 33% reduction.
Total Aust. jobyears for manufacture + installation	70-90	3.7 jobyear /MW (i.e. 50% Aust. Content)	Reflects falling total jobyears yet increasing Australian content giving 4.5 jobyears /MW for installations in 2010
Ongoing Aust. O&M jobs	1-3	0.12 jobs /MW	Falls at 9% annually to 0.06 jobs/MW for installations in 2010 –overall 50% reduction.
Ongoing O&M expenditure	$360-400k /year	$18k /MW per year	Falls with falling capital costs to $12k /MW for installations in 2010

5 SCENARIO OUTCOMES

The scenario outcomes are summarised in Tables 4 and 5. For each of the *Low*, *Medium* and *High* scenarios, these outcomes include total expenditure and job creation outcomes summed over the eight years 2002-10, and Australian wind industry spending and employment in 2010.

These outcomes have been rounded for greater convenience and to reflect the considerable approximations and assumptions required in their estimation. Given present wind project plans and the project financing advantages of earlier projects over MRET's 2020 horizon, the *Low* scenario based on the present MRET target is assumed to see all 1000MW of wind generation installed by 2007. Local content then averages only 70% given less local manufacture.

Table 4. Estimated scenario outcomes - cumulative over the period 2002-2010[5]

Scenario	Installed capacity (MW)	Energy production (GWh)	Total Cap. investment (A$m)	Total Aust. Component (A$m)	Aust. Manuf. & construction jobs (jobyears)	O&M expenditure (A$m)	Aust. O&M jobyears
Low	1000	19,000	1400	1000	4000	50	230
Medium	3000	35,000	4000	3200	13000	160	840
High	5000	57,000	6700	5400	22000	260	1400

Table 5. Scenario outcomes for the size of the Australian wind industry in 2010[6]

Scenario	Annual Aust. installations (MW)	Generation (GWh)	Annual Cap. investment (A$m)	Annual Aust. Component (A$m)	Aust. Manuf. & construction jobs	Annual O&M expenditure (A$m)	Aust. O&M jobs
Low	300	3200	390	310	1300	15	80
Medium	600	9700	740	670	2800	40	210
High	1100	16,000	1300	1100	4800	65	360

[5] The 'Low' scenario sees all 1000MW installed by 2007, so 2008-2010 energy production is at. 2007 levels.

[6] The 'Low' scenario outcomes are for 2007.

These outcomes need to be treated with considerable caution given the difficulties and approximations required in their estimation. One very important factor in the size of the industry in 2010 is whether wind capacity is going to continue to grow or, perhaps, be already tapering off given specific policy drivers. Regardless, these scenarios suggest that the Australian wind industry has the potential to deliver significant investment and employment over the coming decade. A target of 5000MW installed wind capacity in Australia by 2010 might see development of an industry here with A$1.3 billion expenditure a year (90% of this spent in Australia) and providing around 5000 direct jobs in manufacturing and installation.

6 ACKNOWLEDGEMENTS

This project was undertaken by the ACRE Energy Policy Group, with additional support provided by the Australian Ecogeneration Association (AEA) and the Renewable Energy Generators of Australia (REGA). We are particularly grateful for the support and information provided by a number of companies involved in the Australian wind industry. All errors are the responsibility of the authors.

7 REFERENCES

ACIL (2000) *Employment Indicators for Australia's Renewable Energy Industries – Synopsis*, A report for the Sustainable Energy Development Authority, NSW State Government.

Adelaide Advertiser (2002) "All clear for largest wind farm", 26 July, 2002.

AEA (2001) Australian Ecogeneration Association, "Delivering the renewable Energy Target", *Ecogeneration Magazine*, October/November 2001.

AEA (2002) Australian Ecogeneration Association, *RECs, Baselines and Industry Development.* Executive summary available from www.aea.com.au.

AusWEA (2002) *IEA Wind Energy 2001 Annual Report – National Activities for Australia,* available from www.auswea.com.au.

DWIA (2002) *Wind power guide*, Danish Wind Industry Association, available from www.windpower.org accessed August 2002.

EWEA (2002) *Wind Force 12 – A Blueprint to Achieve 12% of the World's Electricity from Wind Power by 2020*, European Wind Energy Association and Greenpeace sponsored study, available at www.greenpeace.org.

Gipe P. (2002) "Soaring to new heights – the world wind energy market" in *Renewable Energy World*, July-August 2002.

Greenpeace (2001) *Wind Force 10 – A Blueprint to Achieve 10% of the World's Electricity from Wind Power by 2020: The Australian Contribution*, available at www.greepeace.org.au.

Harding J. (2002) "Growth of the Australian Wind Energy Industry", in *Proc. IBC Australian Wind Energy Conference*, Melbourne, April 2002.

Hydro Tasmania (2002) "Press release - Hydro Tasmania to purchase 128MW of Vestas machines" available at www.auswea.com.au accessed 28/8/2002.

IEA (1999) *The Evolving Renewable Energy Market*, IEA Renewable Energy Working Party, International Energy Agency.

MacGill I.F., M. Watt and R. Passey (2002a) *Jobs and Investment Potential of Renewable Energy: Australian Case Studies*, ACRE AEPG report available from www.acre.ee.unsw.edu.au, March 2002.

MacGill I.F. and M.E. Watt (2002b) *Jobs and Investment Potential of Renewable Energy: Australian Industry Scenarios*, forthcoming ACRE AEPG report.

PacificHydro (2002) "Press release – Preferred wind turbine supplier announced for $300M Portland wind energy project" available at www.pacifichydro.com.au accessed 28/8/2002.

Redding G. (2002) "Where is renewable energy going in Australia?" in *Proc. ESAA Eighth Renewable and Sustainable Power Conference*, Alice Springs, August 2002.

REPP (2001) *The work that goes into renewable energy*, Renewable Energy Policy Project Research Report, 2001.

SKM Sinclair Knight Merz (2001) *The Portland Project – EES report*, available from www.pacifichydro.com.au.

Stanwell Corporation (2002) "Toora Wind Project Update" available from www.stanwell.com accessed 28/8/2002.

Vestas (2002) "Local Manufacturing for Australia's Wind Industry, in *Proc. ESAA Eighth Renewable and Sustainable Power Conference*, Alice Springs, August 2002.