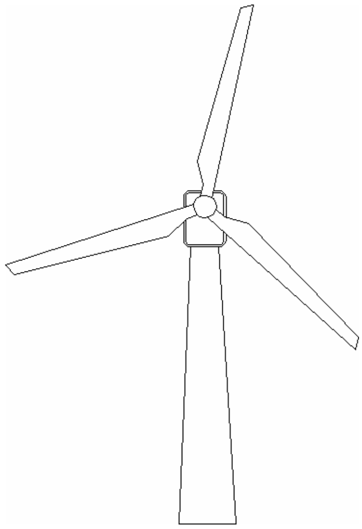
Review of Wind Energy opportunities in Australia and regional markets



"Renewable energy is no longer a scientific dream; its time has come as a robust technology in the market place of the world, a market place in which Australia must play a significant role."

Martin Thomas
Founding Managing Director of ACRE and former President of the IEAust. [1]

Paper for the Institution of Engineers, Australia
Multi-disciplinary Engineering Transactions

February 1999

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1. EXECUTIVE SUMMARY

The dramatic growth of grid connected wind generation is one of the most exciting developments in renewable energy technology during the past decade.

World capacity currently exceeds 8000 MW from over 35,000 wind turbines and, with an annual growth rate in excess of 20%, the industry is substantially outstripping the development of most other new power sources.

Wind turbine ratings of between 500kW and 1500kW are common and prototype single units up to 3 MW are being developed. A variety of technologies are in use including variable and fixed speed, synchronous and induction generators driven by geared or directly coupled blades which are either pitch or stall regulated. Installations vary from single units up to multi-turbine farms of 30-plus MW.

Following significant early developments in California and other parts of the USA during the 1980s, the focus of the wind energy market has shifted to Europe. Denmark and Germany have become the dominant players, both for demand and as manufacturing bases. Other European countries contributing to strong growth in wind power include the Netherlands, UK and Spain. The European Union plans to install at least a further 10,000 MW of new wind capacity, worth A$15 billion during the next few years and some projections point to as much as 40,000 MW by 2010.

The USA experienced flat demand for some years but currently has a short term boost with over 800 MW of new installations under construction to secure tax credits by the middle of 1999. In Asia, India and China have growing markets and host several joint-venture manufacturing facilities.

The principal driver for this growth has been a combination of strong government support for grid connected renewable energy and the vision of entrepreneurial private sector developers and equipment manufacturers. Whilst subsidies provided the initial impetus, many wind farms are now competing directly with traditional high cost fossil fuelled power generation in some countries. Installed costs have fallen to around A$2000 per kW - less than one third of the early 1980 levels - as volume increased and technology improved. Energy prices have dropped even more dramatically to less than 10 A¢/kWh and both figures are continuing to fall. For comparison, photo-voltaic solar electricity is at least three times the cost of wind power.

Australia has been slow to embrace grid connected wind power, with less than 1 MW installed by the end of 1997 (and 3.3 MW in wind-diesel powered systems, mostly at Esperance in WA). However, in 1998 Pacific Power commissioned a 5 MW farm at Crookwell in NSW and there are presently several wind farms in the planning stages totalling more than 80 MW.

Federal Government support is growing in response to the international movement towards greenhouse gas limitation and its "Climate Change Package" includes A$ 65 million for renewable energy. Electricity retailers will be required to source an extra 2% from renewables by 2010. Market driven demand schemes such as SEDA's "Green Power" are providing a financial incentive for the installation of renewable grid generation.

Renewable and electricity industry bodies have estimated that the yearly total output of between 4000 and 9000 GWh from new renewable sources will be required to provide the 2% target.

Wind energy in Australia represents a potential market of between 500 and 1000 MW, worth up to A$ 1.5 billion over the next ten years, creating significant commercial opportunity for Australian power system developers, investors, design consultants, project managers, legal/financial advisers and manufacturers.

2. INTRODUCTION

Wind energy is growing rapidly around the World. Australia has been slow to embrace this source of renewable power but interest is accelerating and several projects are in progress. The purpose of this report is to encourage further debate and action by the Australian energy systems community aimed at creating long-term commercial advantage from exportable wind technology. The report examines the wind energy market and points to both domestic and international opportunities. Recommendations are made for market entry options.

3. SCOPE

The scope of this report is as follows:

3.1 Overview of international wind energy market

Installed capacity, Technology, Key players, Market drivers, Asia & New Zealand

3.2 Australian scene

Existing sites, Wind resources, Key players, Market initiatives, Future developments

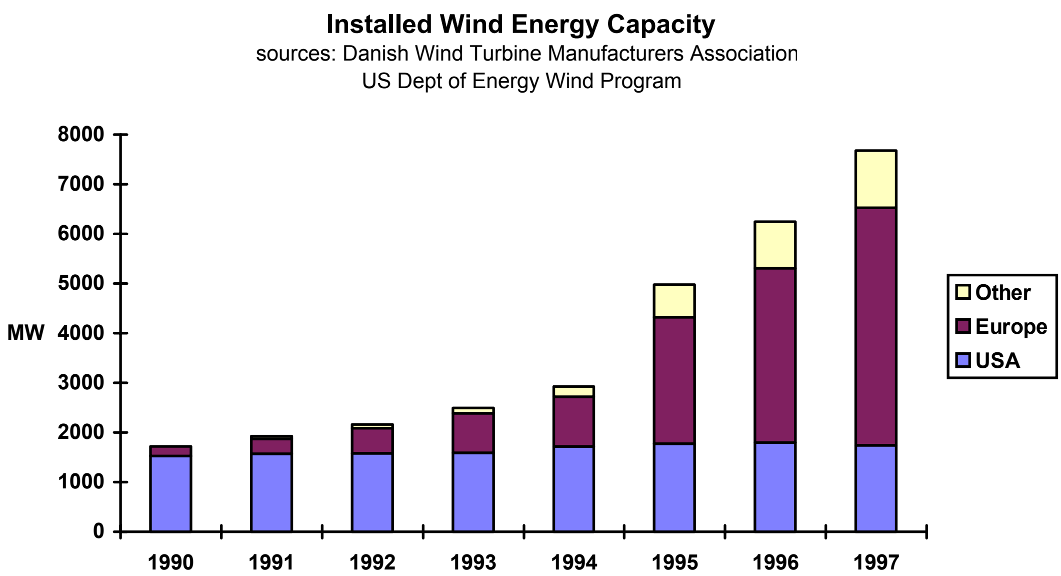
3.3 Opportunities for the Australian energy systems industry

Market opportunities, Recommendations and Conclusion

4. OVERVIEW OF INTERNATIONAL WIND ENERGY MARKET

4.1 Installed capacity

Capacity has grown rapidly during the past few years exceeding 8000 MW by mid 1998. World market demand has grown from around 200 MW p.a. in 1990 to 1600 MW p.a. in



1997. Projections are for 3000 MW p.a. by 2000. 1998 European capacity was 6300 MW. The European market is expected to grow most rapidly from 4780 MW in 1997 to 10000 MW by 2000, at an average growth rate of approx 22% p.a.[2] . Some projections suggest 40,000 MW by 2010. The USA will be a major market for new large machines to replace older smaller units but overall growth is low. Most of the other growth is in India and Asia.

Germany, Denmark, Holland, Spain and the UK are the major European markets

Country	New capacity 1992- 96 MW	Total installed to 1996 MW	Additional Capacity 1997 MW
Germany	1442	1552	450
Denmark	426	835	286
Spain	133	249	200
Holland	249	299	50
UK	261	273	60

In 1996 the World market was worth roughly US$ 1,100 mill (A$ 1,720 mill) [3] By 1998 sales by Danish manufacturers alone had reached US$1bn with $1.2bn forecast in 1999.

4.2 Technology

Average wind turbine ratings have increased from 30 kW in 1983 to just over 750 kW in 1997. Most major manufacturers now make a 1000 kW machine and are developing 1500 kW plus, but 600 to 750 kW is the most common rating having optimum manufacturing and installation costs per kW. The largest single unit yet built is rated at 3000 kW.

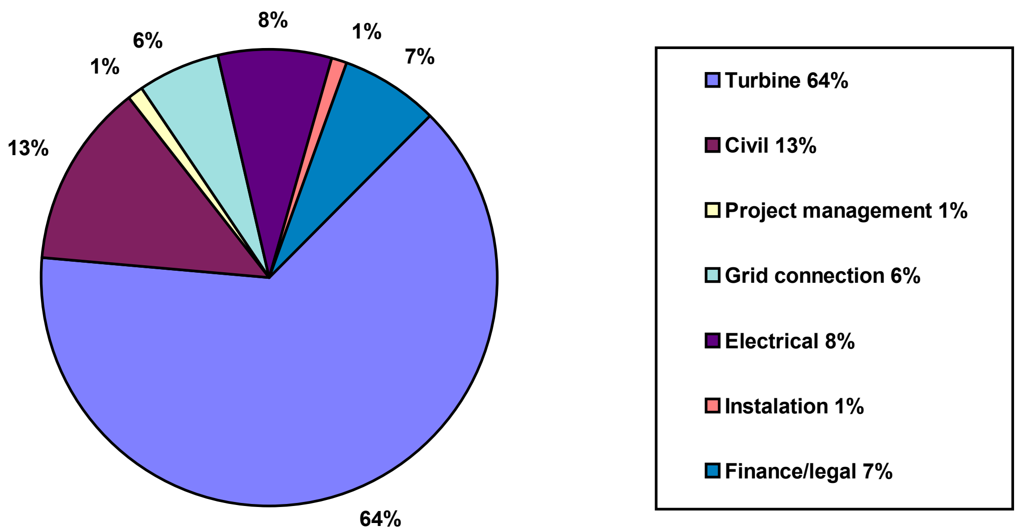
- **Generators** - Most are asynchronous induction machines, which only produce electrical output power when being driven just above synchronous speed. They are often double wound for two constant speeds e.g 250/600 kW @6/4pole. Some designs use variable speed synchronous generators with the output converted to constant frequency via a rectifier/inverter.
- **Turbines** - Three blades are most common but two, or even one with a counterbalance, are also used. Pitch can be variable or fixed - in the latter case over-speeding is prevented by blade design promoting stall conditions at high wind velocity. Variable pitch is common with induction generators so that rotational speed can be kept constant over varying wind conditions. Power is usually generated with wind speed between 4 and 25 m/s with nominal output around 16 m/s.(55 kph)
- **Nacelles** - Most large machines have upwind turbines so the nacelle has to be steered into the wind by a yaw motor via an automatic control system. Generally there is a gearbox to connect the slow speed turbine the higher speed generator(s). Some smaller machines have the turbine downwind of the nacelle so are self-steering. Mechanical braking systems are used on main shaft and yaw.
- **Towers** - Tubular steel towers are most common for environmental and operational safety reasons but lattice types have been used on smaller ratings.
- **Electrical system** - Apart from the generators, many of which produce output power at 690V the electrics include computer based control/protection system, soft starter, LV circuit breaker, power factor correction capacitors, auxiliary power to yaw & pitch motors etc. For multi turbine sites there are SCADA communications to a central control point, unit step-up ring-main substations to MV reticulation and main step-up substation to HV grid. Some towers are designed with a transformer in the base.

For example, the 600 kW Vestas machine at Kooragang Island in NSW has a three bladed variable pitch upwind turbine with 22 m GRP blades running at 28 rpm, a planetary gearbox and an asynchronous 1500 -1650 rpm 690 V induction generator. Swept area is 1520 m^2. The tubular steel tower is 50 m high. Full output is produced at a wind speed of 17 m/s. A variable slip feature allows for up to 10% generator speed variation during wind gusts without causing output flicker. Power is stepped up to 33 kV via an external substation. All up weight is around 80 T of which the nacelle weighs 23 T.

4.3 Economics

Installed cost for medium sized wind turbines has fallen from around US $ 4000 (A$ 6250) per kW in 1980 to US$1250 (A$ 1950) with energy costs falling from 40 to 5 US¢/kWh (63 to 8 A¢). 95%-plus availability and utilisation/load capacity factors of up to 40% are common, resulting in outputs of around 1200 kWh/m^2/year. 600 kW machines generally achieve around 1500 MWh/year on good sites. (c.f Solar PV @A$ 9500/kW - 55 A¢/kWh)

600 kW machines have a list price of around US$ 480,000 (A$ 750,000) plus installation costs. (Exchange rates A$ 1= US$ 0.64, DM 1.13)
Cost breakdown per UK figures is shown below.[4]



The Kooragang Island installation in Newcastle, NSW, cost A$ 1.5 million and is expected to produce 1000 MWh/year which sells via the energyAustralia "Pure Energy" scheme at around 14 A¢/kWh.

4.4 Key players

Based on 1997 sales the ranking of major manufacturers was as follows:

Company	Country	Share	MW sales	Max unit kW
NEG-Micon	Denmark/Ger	19.7%	309	1500 - A/F/G
Vestas	Denmark	18.5%	290+	1650 - A/F/G
Enercon	Germany	14.2%	223	1500 - S/V/N
Bonus	Germany	14.1%	222	1000 - A/F/G
Gamesa	Spain	5.9%	93	600
Made	Spain	4.8%	75	
Nordex	Denmark	4.3%	67	1300 -
Desarollos	Spain	3.4	54	
Zond / Enron	USA	2.4%	38	750 - /V/G
Wind World	Denmark	1.9%	29	750
Tacke	Germany	1.8%	29	1500 -
Others		7.2%	113	

Total		98.4%	1542	

Source - Danish Wind Manufacturers Assn, Other sources put Vestas output at 383MW

Other manufacturers of large machines include:

Company	Country	Max kW
Wincon	Denmark	600 - A/F/G
Jacobs	Germany	600 - A/F/G
De Wind	Germany	600 - A/V/G
Windtec	Germany	1500 - A/V/G
Sudwind	Germany	750 - /V/G
Windmaster	Netherlands	
Lagerwey	Netherlands	750 -
Kvaerner	Sweden	3000 - S/V/G
Nordic Wind	Sweden	1000 - /V/G
Turbowinds	Belgium	600
West	Italy	2000 - S/V/G
NEPC Micon	India	600 - A/F/G
Mitsubishi	Japan	300 - A/F/G

A-asynchronous / S-synchronous, V-variable speed / F-fixed speed, G-gearbox / N-no gearbox

NEG-Micon have recently taken over Kenetech USA, NedWind Holland, Wind World 97 Denmark, DanControl a Danish based wind turbine controls company and Wind Energy Group / Taywood turbine blades from Taylor Woodrow UK. Tacke has been acquired by Enron Wind Corp USA who also own Zond. Vestas were ranked No1 in 1996 with sales of 308 MW and may still hold this position if the alternative 1997 sales figure of 383 MW is accepted. Several manufacturers have established manufacturing/assembly in target markets such as USA, Spain, India and China.

4.5 Market drivers

Positive Government policy on renewable energy is the single biggest demand driver for wind energy. This has been most evident in Europe because of atmospheric pollution concerns since every kWh of wind energy displaces the emission of up to 1kg of carbon dioxide. At Kyoto in Dec 1997 the EU committed to 15% reduction in greenhouse gases by 2010.

In Germany, the Electrical Feed Law (Stromeinspeisungsgesetz) was introduced in 1991 and grants a guaranteed price to private producers of renewable energy which utilities are obliged to pay - 90% of the national average -16.79 Pf/kWh (approx A¢ 15).

Denmark has similar legislation although much of the initiative for wind power has come from public co-operatives or guilds and private individuals who own the majority of the wind turbines. Wind energy is sold at 85% of the price paid by larger electricity users.

The UK introduced the Non Fossil Fuel Obligation (NFFO) in 1989 in order to support its nuclear industry. An initial electricity price levy of 10% was imposed - this has dropped to 2.2%, most of which now goes to renewables as the nuclear subsidy ceases this year. Contracts were let under the NFFO to install wind farms and from 1991 to 1997 the energy cost bids for large projects have more than halved as technology developed and turbine size increased -Stg 8.5 to 3.53 p/kWh (approx 20 to 8.5 A¢) [5]

The USA has a Production Tax Credit (PTC) of 1.5 US¢/kWh for the first ten years of a wind farm's life but this is due to end by mid 1999. The Department of Energy runs the National Renewable Energy Laboratory and Sandia Laboratory. Several major wind projects are underway up to 75 MW e.g. Enron are building a 39 MW farm in California using Zond turbines

Whilst there are socio-economic and political forces driving wind power there is also considerable resistance from some utilities and from local residents living near the wind farms. In Germany Preusen Elektra is fighting a legal battle to avoid having to pay a premium for wind energy on the basis that the law is anti-competitive.

Wind energy penetration of total electrical energy demand is as follows:[6]

Denmark	California	Germany	UK
3.7%	1.5%	0.5%	0.1%

Predictions for 2010 renewables penetration vary from 2% in USA[7] to 10% in Europe[8]. Even at 10% in the USA it is estimated to add only US$ 1.3 to a typical monthly household bill.[9]

4.6 Asia

Installed wind capacity in India was 870 MW at the end of 1997, which is the largest among developing countries. Government support is provided through the Ministry of Non Conventional Energy Sources (MNES) and the Indian Renewable Energy Development Agency (IREDA) as well as state power utilities. Target capacity by 2000 is 2000 MW.[10]

One of the initiatives to establish wind power in India was aid funding from the Danish International Development Agency (DANIDA) which has supported over 50 MW of demonstration projects to date and has made US$ 50 million of tied aid available for future purchase of Danish equipment. The World Bank and Asian Development Bank have also provided concessional lines of credit worth over US$ 78 million for wind projects. The bulk of installed capacity is privately funded with government fiscal incentives such as 100% depreciation for tax purposes in the first year. Special import duty provisions on components also exist to encourage local manufacture.

NEG-Micon has a joint venture manufacturing facility with Natural Energy Processing Company (NEPC-Micon) and there are eleven other active joint ventures involving leading European manufacturers in various levels of local content, mostly up to 250 kW although several are moving towards 600 kW machines.

China had 179 MW of wind capacity by the end of 1997, more than half of which was installed that year. The government estimates that there is 180,000 MW potential over the next 25 years.[11] Nordex have recently entered a J/V with Xian Aero engine Co and China Aviation Gas Turbine Power Corp to produce 200 MW over the next two years as part of the government "Ride-the-Wind" plan aimed at 1000 MW by 2000.

4.7 New Zealand

NZ has a 3.5 MW wind farm at Hau Nui and 225 kW at the Brooklyn research site, both of which have high wind speeds around 10 m/s resulting in capacity factors up to 45%. Vestas is building a large wind farm at Tararua near Palmerston North, for Central Power, comprising 48 x 660 kW turbines. This is a purely commercial venture worth US$ 25 million with no investment subsidies. ECNZ is also considering 30 MW at Makara.

5. AUSTRALIAN SCENE

5.1 Existing & projected wind power sites

There are a number of local grid connected or wind-diesel systems in Australia using relatively small machines including Esperance WA 6 x 60 kW, Malabar NSW 1 x 150 kW, Coober Pedy SA 1 x 150 kW and Breamlea VIC 1 x 64 kW. These were installed prior to 1992. Recent initiatives at major sites involve larger machines.

Existing and proposed sites using generators of 225 kW and above

Location	**Esperance**	**King Island**	**Newcastle**	**Thursday Is**	**Crookwell**
State	WA	TAS	NSW	QLD	NSW
Installed	1993	1997	1997	1997	1998
Total MW	2 MW	750 kW	600 kW	450 kW	4.8 MW
Cost A$	5.9 mill	2.5 mill	1.5 mill	2.5 mill	9 mill
Turbines	9 x 225 kW	3 x 250 kW	1 x 600 kW	2 x 225 kW	8 x 600 kW
Manufacturer	Vestas	Nordex	Vestas	Vestas	Vestas
Contractor		Stirling Wind			Vestas
Operator	Western Power	HECT	Energy Australia	FNQEB	Pacific Power/GSE
Wind speed *	7.5 m/s	7.8 m/s		7.5 m/s	
Availability	98%				
Load factor	40%	40%	100%	37%	100%
Power cost	11 A¢/kWh	12 A¢/kWh	14 A¢/kWh	10 A¢/kWh	
MWh/year	5700	2700	900	600	10000
Grid volts	33 kV	11 kV	33 kV	6.6 kV	11/66 kV
Co-generator	Diesel	Diesel	Grid	Diesel	Grid

*average at 10 m height

Location	**Denham**	**Denham**	**Portland**	**Blaney**	**Codrington**
State	WA	WA	VIC	NSW	VIC
Installed	1998	1999	2000	2000	2000
Total MW	230 kW	630 kW	20 MW	10 MW	9.2 MW
Cost A$			40 mill	20 mill	15 mill
Turbines	1 x 225 kW	2 x 225 kW	33 x600 kW	15 x 600	14 x660 kW
Manufacturer	Enercon	Enercon	Tender	Pre-tender	Planning
Contractor	Powercorp	Powercorp			
Operator	Western Power	Western Power	Energy Equity	Pacific Power	SEA/Pacific Hydro
Wind speed *	8.3 m/s	8.3 m/s			
Availability					
Load factor					
Power cost					
MWh/year	340 (part)				

Grid volts	11 kV	11 kV	66 kV		
Co-generator	Diesel	Diesel	Grid	Grid	Grid

Other sites at the feasibility stage include:

Location	**Albany**	**Atherton Tablelands**	**Cape Jervis**	**Lake Bonney**
State	WA	QLD	SA	SA
Total MW	20 MW	20 MW	5 MW	100 MW
Cost A$	35 mill	30 - 40 mill	10 mill	90 mill
Developer	Western Power	Stanwell Corp	ETSA	Private

Several small-scale generators are also in service around 5 kW including units using high technology blades made by a consortium involving Newcastle University. Several Australian built 10 kW machines were installed by CASE/Burns & Roe Worley at Victorian lighthouses in 1997.

5.2 Wind resources

Various estimates have been made of the wind generating capacity in Australia that might be commercially available during the next ten years, but there appears to have been no definitive national study. The figures should be regarded as very rubbery and not necessarily representative of what could actually be installed! Sites with at least 6.5 m/s average wind speed are considered good.

State	**NSW**	**VIC**	**SA**	**TAS**	**WA**	**QLD**	**NT**	**Total**
MW	1500	200	200	1000*	150	100	20	3170

Sources: Electricity utilities, SEDA, Author's estimates

Notes: *The chairman of HECT was recently quoted as saying Tasmania had 1000 MW of wind potential, some of which could be linked to the mainland via Basslink.[12]
BTM Consult estimates that technically available capacity in Australia is between 1638 and 3000 TWh/year.[13] This compares with electricity consumption of 153 TWh in 1995/6. Therefore theoretical wind capacity is at least ten times current national demand! However much of the wind capacity is too remote from load centres to be economically useful.

5.3 Key players

5.3.1 Locally represented wind turbine manufacturers include

- Vestas
- NEG-Micon
- Enercon
- Turbowinds
- Nordex
- Lagerwey

5.3.2 Project developers include

- Pacific Power - NSW (and regional Distribution Utilities)
- energyAustralia - NSW
- Western Power - WA
- Energy Equity - WA
- Green Energy Co (AUSTA & Energy Equity) – QLD
- Stanwell Corporation - QLD
- FNQEB - QLD
- HECT - TAS
- ETSA - SA
- Boral Energy- SA/VIC
- Citipower – VIC
- Pacific Hydro Ltd - VIC

5.3.3 Industry bodies / R&D organisations involved with wind energy

- SEDA (Sustainable Energy Development Association - NSW)
- SEICA (Sustainable Energy Industry Council of Australia)
- ACRE / Murdoch Uni (Australian CRC for Renewable Energy - WA)
- CASE (International Centre for Application of Solar Energy - WA)
- CEPE / Monash Uni (Centre for Electrical Power Engineering / Asia Pacific Wind Energy Centre - VIC)
- Newcastle Uni - (Wind Energy Group - includes energyAustralia - NSW. This group have developed a commercially available 5 kW variable speed turbine)
- CADDET - IEA/OECD Renewable Energy body - ACT
- ATA (Alternative Technology Association - VIC)
- CSIRO (Wind monitoring network - ACT)
- ANZSES (Australian and New Zealand Solar Energy Association)
- REIAA (Renewable Energy Industries Association of Australia)
- SEIAA (Solar Energy Industries Association of Australia - NSW)
- ESAA (Electricity Supply Association of Australia)
- AUSTENERGY (Australian Energy Systems Exporters' Group Limited)
- AEEMA (Australian Electrical and Electronic Manufacturers' Association Limited)

5.4 Renewable energy initiatives

- <u>Federal Government</u> - The "Climate Change Package" of A$180 million over 5 years includes $ 65 million for renewable energy. Electricity retailers must source an extra 2% from renewables by 2010. The "Greenhouse Challenge" has over 100 major signatories and further 114 to sign. A Greenhouse Office established in Canberra. The Dept of Industry Science & Resources (DISR) are developing an Action Agenda for renewables.

- NSW Govt - SEDA's - "Green Power" accreditation scheme e.g energyAustralia's "Pure Energy", has been extended to VIC, QLD and SA. More than 15,000 domestic NSW customers and 800 commercial users are paying 13.95 A¢/kWh for varying proportions of renewable energy which is sourced from hydro, bio-mass, solar and 600 kW wind - approx A$1 a week on the average household electricity bill. Pacific Power and regional Distribution partners are developing major windfarms and solar projects.
- VIC - Citipower are marketing a small amount of "EcoPower" sourced from 68 kW wind and 23 kW solar at a premium of 2.86 A¢/kWh. Demand exceeds supply and the Portland wind farm is expected to provide a major boost to this program. In March 1998 the State Government called for Expressions of Interest to determine the potential for development of renewable energy industries in the State. A major constraint is the current generation pool price, which is artificially low because of competitive market infancy - less than 2 A¢/kWh!
- SA - ETSA are studying suitable sites for wind power and have recently built a hybrid solar/diesel station at Wilpena Pound
- TAS - The Tasmanian Government is trying to encourage a European wind turbine manufacturer to set up in TAS on the basis of guaranteed business. King Island wind farm has been completed. There are ambitious future hopes for large windfarms.
- WA - Western Power are developing wind and solar co-generation to augment remote diesel power stations e.g. Esperance, Denham
- NT - The Power & Water Authority has long term goals for development of renewable energy and is currently applying it to Remote Area Power Supplies (RAPS)
- QLD - The State Government has just announced initiatives to support 30 MW of renewables and "green" accreditation. Austa & Energy Equity are developing bio-mass. Wind has been applied to remote area applications and Stanwell are considering a major windfarm as well as building solar and small scale hydro plant.

5.5 Alternative renewable energy technologies

Is wind the best solution for Australia? Other renewables are briefly described as follows:

- Solar PhotoVoltaic - Solar cells produce low voltage DC and require inverters to convert to mains AC. There is significant Australian R&D and locally manufacture by two companies (Solarex and BP Solar). Solar power is up to five times more expensive than wind and only available in sub Megawatt installations to date so most systems are used for RAPS applications rather than grid connection. energyAustralia have recently installed a 200kW grid connected array at Singleton NSW - the largest in Australia.
- Solar Thermal - Direct heating of water for domestic/commercial use, e.g Solarhart rooftop collectors. Tower/heliostats or parabolic troughs are used to heat a transfer medium for steam turbine generated grid connected electricity. The latter systems are in extensive commercial operation in the USA (350MW) with energy costs of under 12 US¢/kWh.[14]
- Bio-mass - Combustion/gasification of agricultural waste such as timber or sugar cane (bagasse). Significant potential is available from over 13 million tonnes of annual waste estimated to be between 700 and 1000MW. Bio-mass is already in commercial

use, e.g. Amcor pulp & paper mill Maryvale co-generation, and various Queensland sugar mills. The renewable aspect is contentious because of the production of greenhouse gases but can be considered greenhouse neutral where the feedstock is fast growing and acts as a CO_2 sink. Land fill, sewage digestion and other methane collection systems might also be included.

- Hydro - Hydro power forms the majority of Australia's present renewable energy source accounting for approx 9.5% of electricity production. There is limited potential for future development because of site availability and public objections to wilderness flooding. Some further small-scale run-of-river schemes and conversion of water storage reservoirs is being undertaken. There are possible pumped storage options for existing dams, but this tends to work against renewables since it involves off-peak coal fired base-load generation.
- Wave-power - Various types of power generation from wave or tidal energy are in mainly experimental stages of development but not in significant commercial use.

5.6 Environmental impact of wind turbines

Although one of the primary reasons for introducing wind power has been the environmental benefit from reduction to greenhouse emissions there are also negative perceptions, which could work against widespread adoption. For instance, in the UK an anti-wind farm group called Country Guardian has mounted successful lobby campaigns against the siting of specific projects. In Australia, Energy Equity has experienced difficulties in securing planning approval for the Portland wind farm because of concerns over the historical and recreational value of the proposed site.. Nevertheless, overall public opinion is generally supportive.

Key issues and their counter arguments are as follows:

- Noise - modern turbines are very quiet because of blade design and low speed
- Land waste - wind farms can be used for agricultural or recreational use e.g walking
- Visual intrusion - once installed most wind farms become a tourist attraction for their eco-aesthetic qualities and public interest. Less intrusive than EHV powerlines?
- Danger to birds - sites chosen to avoid bird migration routes

5.7 Future developments

Several initiatives are under way which will have a positive impact on wind energy penetration in Australia. They include:

- SEF(Sustainable Energy Forum) - Peak body to combine solar/wind associations
- Australian Wind Energy Handbook in preparation by CEPE/ANZSES
- DIST Renewable Energy Action Agenda
- DPIE White Paper on Sustainable Energy (follow up to Green Paper)?
- Energy Victoria is considering a "Greenpower" accreditation scheme.
- Further projects in NSW, SA and VIC (SEDA objective of 45 MW in NSW by 2001)
- Rising generation pool prices - estimated average 4.2 A¢/kWh over next 15 years
- Increasing International pressure for Australia to reduce greenhouse gas emissions

- Reduced reliance on coal for electricity generation by 2010
- Federal Govt 2% extra renewables Mandate by 2010

5.8 Wind power scenarios - Australia to 2010

Generation is predicted to grow at 2% p.a. from the present installed capacity of approx 39,000 MW to 48,500 MW.in 2010 (11 years) - an ESAA study by NIEIR puts this growth between 2.3% and 1.7%.

The following scenarios are based on energy production growth of 1.7% p.a. from 165 TWh in 1996 to 209 TWh in 2010 and a renewables capacity factor of 30%.

The Mid-range scenario assumes that an extra 2% of energy will be sourced from renewables per the current Federal Government commitment, of which at least half will be from wind. Quantities of wind turbines are based on 600 kW average ratings and value is based on a projected A$ 1500 per kW installed for a medium sized wind farm of 10 to 20 MW.

Scenario	Renewables	Wind	MW	Qty	A$m	Qty/yr	$m/yr
Minimal	Extra 1%	30%	238	397	358	36	33
Mid-range	Extra 2%	50%	795	1325	1192	120	108
Optimistic	Extra 3%	70%	1619	2698	2428	245	221

Pacific Power Chairman, Prof. Fred Hilmer, has said that wind power could supply a large part of the 400 MW of new generation required each year after the national grid reaches capacity early next decade and that costs could fall as low as 2 A¢/kWh.[15]

ESAA CEO, Keith Orchison, recently estimated that up to 4000 MW of new renewable power worth A$ 4 billion was required to meet the Federal Government's objectives - a MW figure supported by Martin Thomas in a speech to ABARE in February 1998, although he estimates the value at between A$ 5 to 10 billion - both substantially higher than the above scenario.

6. OPPORTUNITIES FOR AUSTRALIAN INDUSTRY

The following opportunities could apply both domestically in Australia and in regional markets such as India and China where grid connected wind energy is growing rapidly and Austenergy members are already working in the power industry. The rationale for promoting domestic applications is that demonstrated Australian competence will reinforce credibility in overseas markets. Within its membership Austenergy also has the skills required to establish and operate large-scale wind farms and could use its networking / lobbying capacity to help promote wind energy acceptance.

- Sell switchgear, control gear, cables and substations
- Represent wind turbine manufacturers - agency basis, project management
- Strategic alliance(s) with wind farm developers / turbine manufacturers
- Licensed part-manufacture in Australia -J/V or consortium basis

- Develop specialist electrical packages for turbine builders e.g. power factor correction, inverters (could also apply to solar generation)
- Financial and legal services
- Power system design
- Project development - Main contractors, Build Own & Operate

There are also remote area power supplies (RAPS) opportunities for smaller scale hybrid systems in conjunction with other renewable sources, storage systems and/or diesel.

7. RECOMMENDATIONS

It is recommended that the Australian energy systems industry undertake the following:

- Adopt a positive and proactive approach to the development of wind energy in Australia
- Support appropriate seminars and/or conferences
- Develop more detailed market / opportunity analysis including Asia and India
- Establish a wind energy database with access via web site
- Investigate alternative and complimentary renewable energy sources.
- Promote wind energy opportunities - via seminars/workshops/newsletter
- Engage in renewables debate with Government agencies including DISR, DEST, DFAT, Greenhouse Office, etc.
- Seek support from related organisations e.g. AUSTENERGY, AEEMA, ESAA, SEDA
- Encourage the formation a peak body for wind energy in Australia
- Publicise wind energy and other renewables with the public

8. CONCLUSION

Wind power will form a significant component of World energy supply in the next century.

Wind turbine design has advanced rapidly over the past five years and is now a relatively mature, reliable and economically viable technology at the stage of being widely diffused in farms of 30 MW or more.

Most other renewable energy technologies are struggling to get over the cost/benefit hurdle that stands in the way of widespread commercialisation for Megawatt plus grid connected systems.

Australia is lagging many developed countries in its adoption of wind energy because of entrenched, low-cost, coal and gas generation and minimalist Government intervention but is forecast to implement renewables at an increasing rate, creating a range of domestic opportunities for the Australian energy systems industry.

There is growing willingness of the Australian public to pay a premium for "Green Energy". SEDA's scheme now reaches 13 million people in the eastern states.

At even modest levels of market penetration the potential for wind energy systems in Australia is projected to exceed A$1.5 billion over the next ten years.

The growing demand for wind energy in our targeted regional markets, especially India and China, will create export opportunities for those companies who have embraced wind technology domestically and/or formed strategic alliances with overseas players. The potential market is very hard to quantify but somewhere between 10 to 100 times that in Australia.

The rate at which wind energy is adopted in Australia will depend on a number of factors. These include: the extent and success of Government Greenhouse programs; favourable public opinion; the uptake of Green Energy programs; developments in the competitive electricity/gas market; international pressure for climate change and further technology or volume driven cost/benefit improvements to wind and alternative renewables.

Perhaps the single most important factor will be the vision and determination of those energy system entrepreneurs who embrace the commercial opportunities that wind power offers and work closely with Government agencies, the electricity supply industry and power consumers to create the right conditions for success.

Australia's wind energy market will not just happen - it must be engineered.

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Wind turbine manufacturers

Acknowledgments

The author is grateful for the help and encouragement offered by Dr Andreas Luzzi - ANU/Energy Strategies/ Caddet, Mr Martin Thomas - ACRE, Dr Peter Freere - Monash University, Dr Graham Redding - RMIT, Mr Keith Orchison - ESAA, Mr Gordon Thompson - CASE, Mr Dennis Williams NEG-Micon, Mr Juergen Zimmermann - Powercorp, Mr John Tingate - Vestas, Mr Matthew Rosser - Energy Equity, Mr Robert Stewart - HEC/International Energy Agency - R&D Wind, Mr Bryan Douglas - AEEMA and Mr Peter Cockbain - Ampcontrol, in the preparation and review of this report.

Biodata

David Peck is an Electrical Engineer with over 25 years experience of marketing and business development in the Australian electrical manufacturing industry, including thirteen with Wilson Transformer Company and two as CEO of the Gippsland International engineering network prior to joining Ampcontrol in February 1997 as Business Manager Southern Australia. He has experience in all aspects of engineering management from market identification to installation and commissioning of equipment for Electricity Supply Authorities, Mining and Industrial customers throughout Australia and S.E. Asia. David was also involved in the establishment of Wilson's joint venture manufacturing operation in Malaysia.

He is now actively promoting Ampcontrol's engineering expertise in electrical and electronic equipment for the mining, mineral processing, utility and industrial markets. His interest in wind power started with Ampcontrol's capability as a leading manufacturer of packaged substations, which can be used for wind farm grid connection, and has developed into a strong personal conviction in the future of Australian wind energy. David is Deputy Chairman of Austenergy, the Australian Energy Systems Exporters' Group Limited and a member of the International Greenhouse Partnerships Program review panel.