

Putting Renewables on Target

A 10% Mandatory Renewable Energy Target

A study commissioned by **Greenpeace**
Prepared by **Next Energy**

The Authors

Dr Robin Roy *has over two decades of experience in the energy sector in the U.S. and Australia. Over the last seven years, he has undertaken a wide variety of public and private sector consulting assignments in the Australian energy sector. He is currently a director of the Sydney-based consultancy, Next Energy. Robin was formerly Project Director & Fellow at the United States Congress Office of Technology Assessment where he advised the Congress on competition in the electricity market, energy efficiency initiatives and nuclear industry issues. Prior to that, he worked with Pacific Gas and Electric Company in their strategic planning group. Dr Roy gained a Ph.D., MS and BS from Stanford University.*

Graham Mawer *has spent the past six years working on consulting projects in the Australian energy industry. He is a director of the Sydney-based consultancy Next Energy where he has led a variety of energy efficiency, energy purchasing, energy generation and energy technology projects. Before coming to Australia, he worked for a UK technology consulting firm running their northern England office, serving clients in the energy, petrochemical and product manufacturing sectors. He has previously led a consulting group assisting Canadian companies to enter the emerging Mexican market and worked as an engineering consultant on commercial building projects in Canada. Graham has a B.A.Sc. from the University of Toronto and an MBA from McGill University.*

Putting Renewables on Target
A 10% Mandatory Renewable Energy Target

Contents

Executive Summary

This study was commissioned by Greenpeace Australia Pacific to explore the feasibility of increasing Australia's Mandatory Renewable Energy Target (MRET) to 10% by 2010. An increase in MRET from the current 2% to 10% by 2010 would help obtain economies of scale and scope, and develop a vibrant renewable energy industry.

The study found that there is a strong case that enough new renewable energy sources could be developed to meet a 10% MRET of up to 36,500 GWh per year by 2010 at no or very low cost. This increase from the current 9,500 GWh MRET could be achieved using a combination of potentially high volume sources, including wind energy, solar water heating and sustainable biomass energy from multi-benefit bioenergy crops.

Meeting a 10% MRET would bring significant environmental gains by reducing greenhouse gas emissions by some 26 million tonnes each year[1] (equivalent to taking about 6 million cars off the road) and creating direct permanent employment of over 14,000 new jobs, a large portion of which would be in regional areas of Australia.

AN INCREASE IN MRET FROM THE CURRENT 2% TO 10% BY 2010 WOULD HELP OBTAIN ECONOMIES OF SCALE AND SCOPE, AND DEVELOP A VIBRANT RENEWABLE ENERGY INDUSTRY.

Background

In the lead up to the international climate conference in Kyoto in 1997, the Australian Government announced its intention to increase renewable energy generation as one element of a package announced by the Prime Minister. Legislation establishing the Mandatory Renewable Energy Target (MRET) was passed in 2000, and the Act came into operation in April 2001. A review of the Australian MRET is scheduled to begin in January 2003.

Support for an increase in the target and the move to renewables is growing, in light of several factors:

- the increasingly clear technical capabilities of renewable energy developers in Australia;
- the more ambitious commitments being made internationally; and
- the findings of the Third Assessment Report of the IPCC regarding the science, impacts and urgency of climate change.

In addition, there has been some criticism that the impact of the current target will be substantially diluted due to rapid load growth nationally (so that the 9,500 GWh is no longer equivalent to the original 2% MRET target) and the eligibility of generation from existing large scale hydro-electric schemes to contribute a considerable share of required Renewable Energy Certificates (RECs).

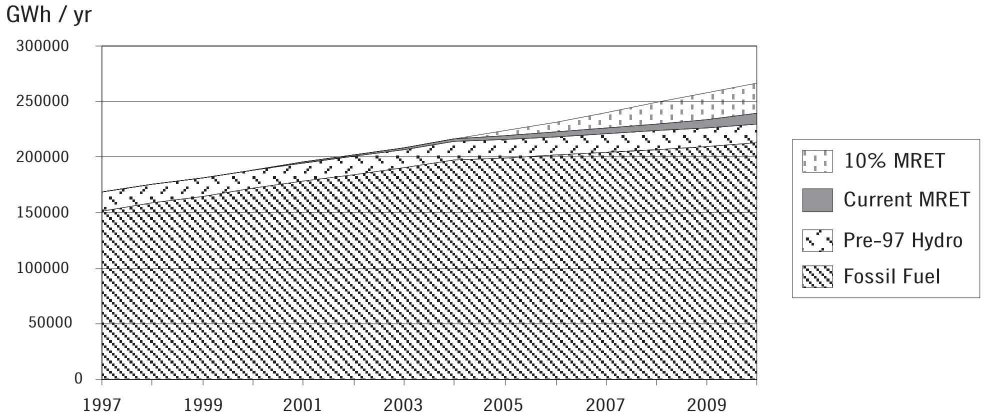
Quantifying a 10% MRET

The rate of electricity demand growth is a critical assumption in calculating the quantity of Renewable Energy Certificates (RECs)[2] that would be required under a 10% MRET. The current 9,500 GWh MRET target by 2010 was based on an assumed 2.1% annual electricity growth rate between 1996-97 and 2010. However, actual growth in electricity demand per year between 1996 and 2000 has been far higher, averaging 3.8%.[3] Furthermore, recent projections suggest that electricity growth throughout the decade may be 2.2% to 3.5%.[4] A 10% MRET would therefore equate to 30,100 - 36,500 GWh in 2010, assuming a 2.2% to 3.5% annual growth rate.

As the next figure illustrates, the current 9,500 GWh MRET will have only a modest effect in levelling off the growth of fossil fuels in the electricity sector. Even a 10% MRET would not curtail growth but growth would be slowed, making a contribution to controlling greenhouse gas emissions and limiting further investment in new fossil fuel power generation capacity.

Contribution of a 10% MRET to Electricity Supply

Assumes 3.5% load growth 2000 to 2010



Incremental Cost of RECs & the Significance of International Commitments

The cost of supplying RECs will depend on the cost and potential volume of renewable generation, the cost of other electricity supplies that renewable sources displace and, in particular, on the cost difference between the two. Both the cost of renewable sources in 2010 and the cost of the conventional sources they would displace are uncertain.

However, one critical factor influencing the future cost of electricity sources that the additional renewables would displace is the cost of complying with Australia's international greenhouse gas commitments. While Australia has not ratified the Kyoto Protocol, and the Protocol is yet to come into force, the likelihood of it becoming law by 2003 has increased following Russia's statement at the World Summit on Sustainable Development (WSSD) that it would ratify. In any case, the Australian Government has committed to meet its Kyoto obligation even if it does not ratify. Accordingly, it is likely that there will be some direct or indirect value on carbon emissions by 2010, which should be viewed as an additional cost for non-renewable sources of electricity.

The future cost of CO_2 is speculative. However, it is reasonable to expect (and, we believe, more plausible) that the cost will be significantly greater than the $0 that has been implicitly assumed in some other analyses of MRET, including the analysis of future RECs prices produced for the Australian Greenhouse Office in 2000.[5]

This study assumes a cost of $20 per tonne for CO_2 emissions which is within the range of $10 to $50 per tonne that has been previously suggested as plausible by the Australian Greenhouse Office.[6] Based on a cost of $20 per tonne, one analysis for the National Electricity Market Management Company estimated that the electricity price in the National Electricity Market could rise by about $10 to $15 per MWh, from $40 to $45 per MWh expected in 2010, to a total price of $50 to $60 per MWh.[7]

The price range of $50 to $60 per MWh reflects the incremental use of existing generation, typically the most expensive incremental capacity, as well as the development of new generation required to meet project load growth of about 30% over the decade. Accordingly, this study assumes that the projected price of $50 to $60 per MWh in 2010 is indicative of the incremental cost of other electricity sources that the additional renewable sources would displace. In short, there is a strong case that potential REC sources costing in the range of $50 to $60 per MWh would have no incremental cost relative to the non-renewable sources they displace.[8]

Finally, it is worth noting that the cost to create RECs is likely to be less than the total price

THERE IS A STRONG CASE THAT POTENTIAL REC SOURCES COSTING IN THE RANGE OF $50 TO $60 PER MWh WOULD HAVE NO INCREMENTAL COST RELATIVE TO THE NON-RENEWABLE SOURCES THEY DISPLACE.

that might be paid to purchase RECs. This is because the price of RECs will depend heavily on the cost of the marginal, or most expensive, REC. However, much of the new renewable energy capacity will cost much less than this. Also, some projects may bring additional benefits, in salinity management for example, that may have non-energy related value.

Potential Sources for a 10% MRET by 2010

A large assortment of renewable energy technologies has been identified as likely to contribute to the existing 9,500 GWh MRET. There do not appear to be any significant technical or commercial barriers to achieving this target, although many in the renewable energy industry are highlighting the shortfalls in the current regulatory framework governing the electricity industry. This includes access to the transmission network and inappropriate treatment of decentralised generation.

Achieving a 10% MRET of 30,100-36,500 GWh, however, would require intensive development of a different mix of renewable energy technologies and on a different scale than that envisioned under a 9,500 GWh MRET. While there are many prospective sources that may prove attractive over time, this study identified three prospects as particularly warranting attention. These are wind energy, solar water heating and bioenergy from new multiple-benefit revegetation projects. Each could potentially supply a large fraction of the additional GWh that would be required. Successfully developing each to such a large extent would also require addressing a variety of significant challenges. However, this study assumes that the climate change issue will be viewed as an increasing priority, and that government and societal attention would be devoted to addressing these challenges accordingly.

IN THE PROCESS OF MEETING A 10% MRET, SOME 26 MILLION TONNES OF CO_2 EMISSIONS COULD BE AVOIDED AND 14,000 DIRECT PERMANENT JOBS WOULD BE CREATED.

Wind energy technology has consistently delivered cost and performance improvements over the past decade, and the outlook is for more of the same. With successful management of challenges such as transmission access and pricing, and management of land use issues, the incremental cost of RECs above the NEM wholesale energy price from wind could be zero.

Similarly, solar water heating is already economically attractive today, although there is a variety of barriers to greater uptake by consumers. Large scale deployment would be likely to deliver far lower costs, making it a potentially major source of RECs at no net cost. The key challenges lie in developing building and appliance energy standards.

Multi-benefit bioenergy crops could potentially provide large numbers of RECs while simultaneously contributing to other environmental and economic needs. For example, revegetation of land currently at risk from salinity could be done using a variety of energy crops, yielding energy, salinity management, and other commercial benefits from the crops. Given the high cost to the economy of salinity, currently estimated at $3.5 billion per year,[9] the net cost of RECs could be low or zero. Key challenges lie in developing and applying an effective sustainable biomass policy, as well as in achieving effective revenues from the other benefits, particularly environmental ones.

It should be noted that if a shortfall of new renewables occurs, the MRET obligations would then be met by payments made to the government in lieu of RECs. This source of government revenue could be used for a variety of purposes to specifically foster the further uptake of renewables such as additional renewable energy research and development (R&D) or to fund specific renewable energy projects.

Together with the 9,500 GWh required under the current MRET, the above sources could supply over 46,500 GWh of RECs in 2010 if implementation challenges were successfully addressed (see Table 1). This is well in excess of the 30,100 to 36,500 GWh required to meet a 10% MRET and suggests that, while such a target is ambitious, it is achievable.

In the process of meeting a 10% MRET, some 26 million tonnes of CO_2 emissions could be avoided and 14,000 direct permanent jobs would be created.[10] The majority of the jobs generated would be in regional Australia. In addition, Australian companies would develop significant export potential because of the economies of scale achieved in R&D, manufacturing and marketing.

Table 1. Potential MRET Sources in Addition to Current 9,500 GWh Requirement (as detailed in main body of Study)

SOURCE	POTENTIAL (GWh / yr)	COST OF RECs [11] ($ / MWh)	COST OF RENEWABLE ENERGY IN 2010 ($ / MWh)	DIRECT JOBS CREATED	KEY STRENGTHS	POSSIBLE CHALLENGES
Wind	15,000+	$0 to $5	Around $55	3,300	➲ Well demonstrated ➲ Large resource ➲ Relatively low and declining costs ➲ Rapid installation	➲ Transmission infrastructure and pricing ➲ Value at high deployment levels ➲ System operating issues at high deployment levels ➲ Land use considerations
Solar Water Heating	13,000	$0	Under $40	6,000	➲ Well demonstrated ➲ Large potential supply ➲ Prospects for excellent economics at high deployment levels	➲ Consumer behaviour alone unlikely to achieve high deployment ➲ High deployment likely to require government mandates in building and appliance energy codes
Biomass from new multiple benefit re-vegetation projects	10,000+	$0 to $10	$50 to $60	5,000	➲ Large potential resource ➲ Potentially attractive economics based on multiple-benefits including energy, wood products, reduced erosion, reduced salinity, increased biodiversity and increased land value	➲ Demonstrating production systems bringing low cost and high performance for multiple commercial products ➲ Integrating bioenergy with the broader scientific, technical and institutional challenges presented by sustainable dryland salinity management ➲ Seasonal fuel source ➲ Creation of new markets ➲ Transport costs
TOTAL	**37,000+**	**$0 – $10**	**<$40 TO $60**	**14,300**		

Acronyms

AGO	Australian Greenhouse Office
GHG	Greenhouse Gases
GWh	Gigawatt-hour (1 GWh = 1,000 MWh = 1,000,000 kWh)
IPCC	Intergovernmental Panel on Climate Change
kWh	kilowatt-hour
MRET	Mandatory Renewable Energy Target
MW	Megawatt
MWh	Megawatt-hour (a typical Australian household uses 5MWh / yr)
NEM	National Electricity Market
NEMMCO	National Electricity Market Management Company
REC	Renewable Energy Certificate
RECs	Renewable Energy Certificates
SWH	Solar Water Heating
PV	Photovoltaics (solar electric power)

1. Introduction

1.1 Background

In the lead up to the international climate conference in Kyoto in 1997, Australia committed to a policy of mandating an increase in renewable energy generation as one element of a package announced by the Prime Minister.[12] The goal was to increase the share of renewable energy in the electricity sector by 2%, from about 10% in 1996-97 (virtually entirely supplied by large hydro-electric projects), to 12% in 2010.[13] The legislation establishing the Mandatory Renewable Energy Target (MRET) was passed in 2000, and the Act came into operation in April 2001 (see side bar).

Since Australia announced its 2% goal, at least two other countries, the United Kingdom and the Netherlands, and several states in the United States of America, have adopted mandatory renewable energy targets as well.

The United Kingdom has set a target of achieving a 10% market share from renewable sources in 2010, an increase from about 2.75% in 2000, and is currently examining extending the target to 20% by 2020.[14] In at least 14 US States (Arizona, Connecticut, Hawaii, Iowa, Illinois, Maine, Massachusetts, Minnesota, Nevada, New Jersey, New Mexico, Pennsylvania, Texas and Wisconsin)[15] a mandatory renewable portfolio standard has been introduced ranging from 0.2% to 30%. In many of these states, a tradeable REC is used as a way of complying with the state's renewable portfolio standard.

A review of the Australian MRET is scheduled for 2003. In light of the increasingly clear technical capabilities of renewable energy developers in Australia, and of the more ambitious commitments being made internationally, support for an increase in the target to 10% is growing in advance of that review. Major organisations to have indicated their support for a 10% MRET include BP, the Australian Labor Party, the Australian Wind Energy Association and the Australian Business Council for Sustainable Energy.[16]

1.2 The Brief

This study was commissioned by Greenpeace Australia Pacific to explore the feasibility of increasing Australia's Mandatory Renewable Energy Target (MRET) to 10% by 2010.

Uncertainty is unavoidable in forecasts of any market, even in commodities that have been traded far longer than RECs. The objective of this study is not to conclusively predict REC supply and prices for a 10% MRET, but rather to broadly characterise some of the large-scale renewable energy sources that could be achievable, including consideration of possible challenges associated with achieving their potential, and the indicative incremental cost.

1.3 Quantifying a 10% MRET

The rate of electricity demand growth is a critical assumption in calculating the number of RECs that would be required under a 10% MRET.

The current static 9,500 GWh MRET was set based on an assumed 2.1% growth rate in electricity demand between 1996-97 and 2010. However, actual growth between 1996 and 2000 was far higher, averaging 3.8%.[17] Also, recent projections suggest that electricity growth throughout the decade may average 2.2% to 3.5%.[18] Had these higher growth rates been assumed in setting the 2% target, the number of RECs required would have been far higher, at between 11,300 GWh to 15,200 GWh rather than the adopted 9,500 GWh.

Notably, if electricity demand grows at 3.5% per year throughout the decade, the current 9,500 GWh MRET would not result in an additional 2% share for renewable energy. Rather,

MANDATORY RENEWABLE ENERGY TARGET

The Commonwealth Renewable Energy (Electricity) Act 2000 established a target of an additional 9,500 GWh per year of renewable energy by 2010 over the amount generated in 1996-97. The target rises progressively, starting at 300 GWh over the period 1 April to 31 December 2001. To achieve this end, electricity retailers and other large wholesale electricity buyers are required to purchase Renewable Energy Certificates (RECs) in proportion to their electricity purchases. Each REC represents 1 MWh of renewable energy produced from eligible sources.

A penalty of $40 / REC applies if the requirement is not met.

Eligible sources include renewable energy generators commissioned in 1997 or later; solar water heaters in new buildings or where electric water heating is being replaced; and pre-1997 renewable energy generators that increase their production over a specified baseline.

renewable energy would provide only about 9.8% of Australia's electricity in 2010, less than the 10% supplied in 1996-97.

Table 2 shows what a 2%, 5% and 10% target would be in 2010, depending on the forecast growth rate. (Note, the percentage target reflects an increase in the share for renewable energy over the level supplied in 1996-97, not the total market share in 2010.) Given that renewable energy (including existing large scale hydro) supplied about 10% in 1996-97, these targets would equate to 12%, 15%, and 20% of electricity supply in 2010.

Table 2. Sensitivity of RECs Required in 2010 to Electricity Demand Growth Assumptions and to the Increase in Market Share for Renewable Energy

		Target GWh per year of new Renewable Energy in 2010		
		2%	**5%**	**10%**
Electricity Demand Growth 2000 – 2010[19]	2.2% / year	11,300	18,400	30,100
	3.5% / year	15,200	23,200	36,500

Note: All cases incorporate actual load growth of 3.8% per year between 1997 and 2000.[20]

THIS IS EQUIVALENT TO TAKING ABOUT 6 MILLION CARS OFF THE ROAD, OR ABOUT 6% OF AUSTRALIA'S TOTAL 1999 EMISSIONS.

As indicated in the table, a 10% MRET could require between 30,100 GWh and 36,500 GWh under a reasonable range of forecasts of load growth.

Assuming that the alternative is to increase fossil fuel utilisation, there would be considerable greenhouse gas emission savings with a 10% MRET. For example, at an average emissions rate of some 0.98 tonnes of CO_2 per MWh[21] for current electricity production in Australia, the additional 27,000 GWh over and above the current 9,500 GWh target would equate to some 26 million tonnes of CO_2 / yr in avoided emissions. This is equivalent to taking about 6 million cars off the road, or about 6% of Australia's total 1999 emissions.[22]

1.4 Incremental Cost of RECs and the Significance of International GHG Commitments

This study broadly examines the possible incremental cost of achieving a 10% MRET of 30,100 GWh to 36,500 GWh per year in 2010.

The cost of supplying RECs will depend on the cost and potential volume of renewable generation, the cost of other electricity supplies that renewable sources displace and, in particular, on the cost difference between the two. The displaced sources may be wholesale electricity (e.g. for wind farms supplying the National Electricity Market) or retail electricity (e.g. for solar water heaters displacing electric water heating). Both the cost of renewable sources in 2010 and the cost of the conventional sources they would displace are uncertain.

One critical factor influencing the future cost of electricity sources that the additional renewables would displace is the cost of complying with Australia's international greenhouse gas commitments. While Australia has not ratified the Kyoto Protocol, and the Protocol is yet to come into force, the likelihood of it becoming law by 2003 has increased following Russia's statement at the World Summit on Sustainable Development (WSSD) that it would ratify. In any case, the Australian Government has committed to meeting its Kyoto obligation even if it does not ratify. Accordingly, it is likely that there will be some direct or indirect value on carbon emissions by 2010, which should be viewed as an additional cost for non-renewable sources of electricity.

The future cost of CO_2 is speculative, and the topic deserves more detailed attention that this study allows. However, it is reasonable to expect (and, we believe, more plausible) that the cost will be significantly greater than the $0 that has been implicitly assumed in some other analyses of MRET, including the analysis of future REC prices produced for the Australian Greenhouse Office in 2000.[23]

This study assumes a cost of $20 per tonne for CO_2 emissions which is within the range of the $10 to $50 per tonne that has been previously suggested as plausible by the Australian Greenhouse Office.[24] Based on a cost of $20 per tonne, one analysis for the National Electricity Market Management Company estimated that the electricity price in the National Electricity Market could rise by about $10 to $15 / MWh, from $40 to $45 / MWh expected in 2010, to a total price of $50 to $60 / MWh.[25]

The price range of $50 to $60 / MWh reflects the incremental use of existing generation (typically, the most expensive incremental capacity) as well as the development of new generation required to meet projected load growth of about 30% over the decade (typically, new plants would be more expensive than existing generation as the cheapest sites would usually have been developed first). Accordingly, this study assumes that the projected price of $50 to $60 / MWh in 2010 is indicative of the incremental cost of other electricity sources that the additional renewable sources would displace. One caveat is that the average NEM price reflects the time-weighted average of prices in each half hour of the year, including both higher-cost (e.g. peak) periods and lower-cost (e.g. off-peak) periods. The cost of displaced generation could be higher or lower than the $50 to $60 / MWh, depending on when the renewable energy sources operate. In short, there is a strong case that potential REC sources costing in the range of $50 to $60 / MWh would have no incremental cost relative to the non-renewable sources they displace.

WHILE AUSTRALIA HAS NOT RATIFIED THE KYOTO PROTOCOL, AND THE PROTOCOL IS YET TO COME INTO FORCE, THE LIKELIHOOD OF IT BECOMING LAW BY 2003 HAS INCREASED

It is worth noting that the cost to create RECs is likely to be far less than the total price that might be paid to purchase RECs. This is because the price of RECs will depend heavily on the cost of the marginal, or most expensive, REC. However, much of the new renewable energy capacity will cost much less than this and some will even have a negative incremental cost. For example, some further performance upgrades at existing hydro-electric generators may be achievable for under $40 / MWh and would be developed regardless of the MRET. For these, there would be no incremental cost of RECs. Previous studies have projected that about 1,700 GWh of new renewable energy would be developed for commercial reasons even without the MRET legislation.[26]

Finally, it should be noted that some projects may bring non-energy related benefits to the economy that may not be reflected by the developer's costs. For example, some biomass projects may provide benefits to dryland salinity management. (See Biomass Section for more detailed discussion of the potential integration of biomass energy crops in salinity management). The extent to which these benefits offset REC prices will depend largely on government policy.

2. Potential REC Sources for a 10% MRET by 2010

This section discusses renewable energy technologies that could potentially be developed on a large scale to meet a 10% MRET of up to 36,500 GWh per year by 2010. These developments would have to greatly exceed the sources already identified for meeting the current 9,500 GWh MRET.

The methodology used was, first, to consider previous research on available sources for meeting the current 9,500 GWh MRET requirements. The potential of the dozen or so most commonly cited sources of renewable energy to supply significantly increased amounts of renewable energy was then considered (see Table 3 for references). Many sources appeared to be resource constrained in delivering much more than the estimates projected under 9,500 GWh (e.g. there are unlikely to be substantial increases in bagasse resource, landfill gas sites, sewage gas opportunities or many new hydro sites identified). Others, even if fully developed, did not appear to have the potential to deliver a large fraction of a 10% MRET (e.g. municipal solid waste and a variety of specialist agricultural wastes). However, three potential sources stood out as possible major sources for a 10% MRET. These were wind, solar hot water and biomass from new multi-benefit revegetation projects.

THREE POTENTIAL SOURCES STOOD OUT AS POSSIBLE MAJOR SOURCES FOR A 10% MRET. THESE WERE WIND, SOLAR HOT WATER AND BIOMASS FROM NEW MULTI-BENEFIT REVEGETATION PROJECTS.

Successfully developing wind, solar and biomass to such a large extent would require addressing a variety of challenges. However, this study assumes that the issue of climate change is viewed as an increasing priority, and that government and societal attention would be devoted to addressing these challenges accordingly.

2.1 The First 9,500 GWh

Just which sources will be developed to supply the existing 9,500 GWh MRET requirements will be determined gradually over the next few years. While the market will be dynamic, several sources already appear likely to play prominent roles.

Table 3 summarises previous analyses of the cost and potential of leading sources that could meet the 9,500 GWh MRET. Prominent on the list are biomass energy from waste, particularly bagasse, solar water heating and wind.

Notably, an analysis by the Australian Business Council for Sustainable Energy (formerly the Australian EcoGeneration Association) has concluded that some large pre-existing hydro generators (i.e. existing prior to 1997) will be able to create about 1,600 GWh of RECs per year by 2010 without undertaking any new investment.[27] This is because they have apparently been given baselines which are "well below their long run average system yield" and because they will be eligible to create RECs in years when production is high (e.g. during high rainfall years) but not have to hand them back in when production is low.

Table 3. Possible Sources to Meet the 9,500 GWh MRET [28]

RESOURCE/ TECHNOLOGY	GWh / year	COST ($ / MWh) 2010
Existing Hydro	1600	n/a
Bagasse	2628	55
Wood & Forestry Waste	1708	55
Solar Water Heating	1051	50
Wind	1226	68
Food & Agricultural Waste	735	60
Municipal Solid Waste	657	60
New Hydro	675	50
Landfill and Sewage Gas	788	55
Other	300	80 – 120
TOTAL	**> 9,500**	**Avg. = <$58**

There is considerable uncertainty about the actual cost and resource potential for the various sources. However, the above appear consistent with previous estimates.[29] Overall, this suggests the first 9,500 GWh of new renewable sources could be delivered at an average cost of about $58 / MWh.[30]

A delivered average cost of under $58 / MWh would suggest that, under the assumptions outlined previously, there will be little or no net societal cost in achieving the current MRET target based on an anticipated wholesale electricity cost in 2010 of $50 – $60 / MWh.[31]

2.2 Additional Wind Energy

2.2.1 Opportunities for Wind Energy in Australia

WIND IS BY FAR THE LEADING PROSPECT FOR LARGE VOLUMES OF NEW RENEWABLE ENERGY IN AUSTRALIA.

Wind is by far the leading prospect for large volumes of new renewable energy in Australia. Wind energy has several strengths:

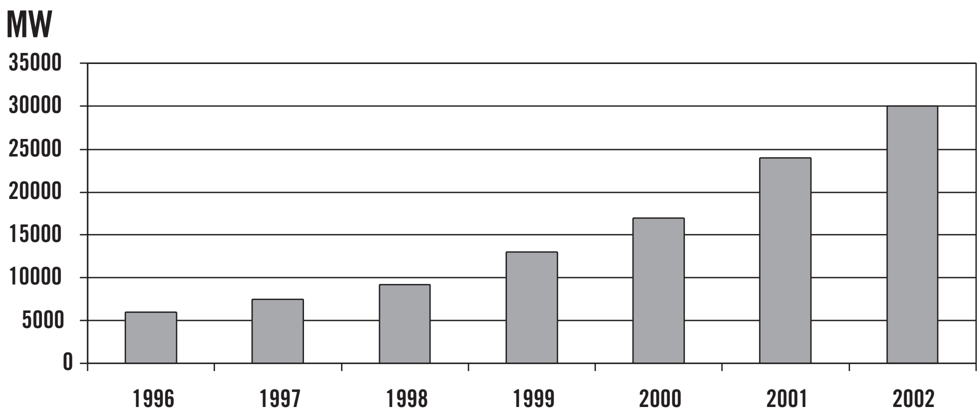
- it is a well demonstrated technology;
- there is a large prospective resource base in Australia; and
- it has experienced a long trend of rapidly declining costs, which is expected to continue for some time.

2.2.1.1 Well demonstrated technology

Globally, the use of wind energy has grown rapidly over the past several years with average annual global growth rates of 20%-30% in recent years.[32] Global capacity in 2001 was approximately 24 GW, and new construction in 2002 is expected to add 6 GW, with major rollouts in several countries (see Figures 1 and 2). This represents global investment in wind projects of more than A$10 billion this year alone.[33]

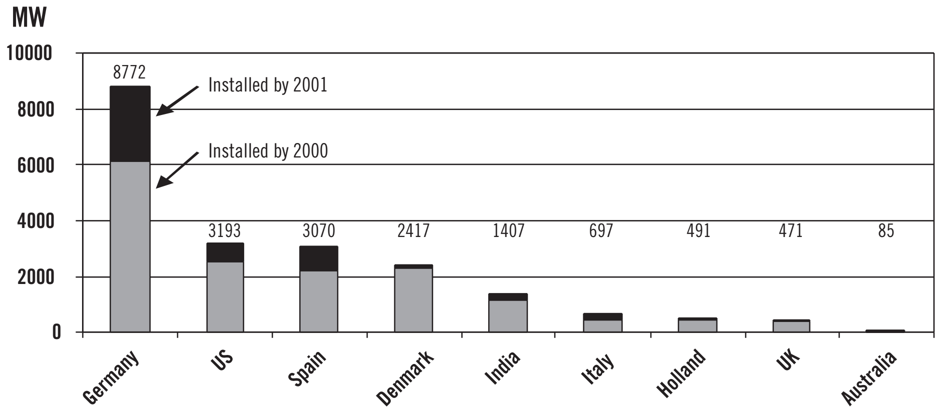
In Australia, wind power capacity jumped from 31.7 MW in 2000 to 84.7 MW in 2001.[34]

Figure 1 – Growth in Global Wind Generating Capacity, MW[35]



Wind has become a centrepiece of many countries' renewable energy programs. Large increases in wind energy are projected in Germany, Spain, Italy, the United Kingdom, the United States, India and other countries, indicating a favourable view of performance to date, and expected continuing favourable performance. For example, France has announced its intention to add about 10,000 MW by 2010; India 6,000 MW by 2012; and in the UK, over 3,400 MW is expected by 2010.[36]

Figure 2 – Global Wind Generating Capacity by Country - 2001[37]



Large Prospective Resource Base in Australia

Generally, an average wind speed of 7 metres per second (m/s) is viewed as potentially commercially viable and speeds over 8 m/s are considered excellent.[38] Australia has extensive areas with average wind speeds that are suitable for the commercial production of wind energy.

The areas identified by project developers as having excellent wind conditions are generally found on the southern coastal areas of Australia and include areas of Western Australia, South Australia, Tasmania and Victoria. Some of the projects in these states that have been proposed or recently approved, but not yet completed, are listed in Table 4.

While these are notable projects, each represents only a small portion of its respective region, indicating a far larger suitable wind resource available. In addition to the above projects, the Australian Wind Energy Association reports that it is aware of another 1,000 MW of projects proposed by industry participants,[40] indicating an even larger potential resource base, and in 2001 set a target of 5,000 MW by 2010, announced jointly with Greenpeace Australia Pacific.

Table 4. A Selection of Proposed Australian Wind Projects[39]

LOCATION / NAME	STATE	PROPONENT	CAPACITY (MW)	COMMENTS
Portland District	VIC	Pacific Hydro	210	Wind farms at Yambuck, Cape Sir William Grant, Cape Nelson and Cape Bridgewater.
Ararat	VIC	Pacific Hydro	75	Has received approval. Also known as Challicum Hills Wind Farm.
Lake Bonney	SA	Babcock and Brown	70 – 100	Equipment supplier and turnkey construction contractor selected.
Woolnorth & Bluff Point	TAS	Hydro Tasmania	65 – 128	First stage in construction.
Yabmana (Eyre Peninsula)	SA	Novera and Wind Prospect	55 – 70	Development Application submitted.
Tungketta Hill (Eyre Peninsula)	SA	Ausker Energies	49 – 115	First phase of 49 MW.
Green Point	SA	Novera and Wind Prospect	40	Obtained provisional planning approval in Nov 2001.
Kongorong	SA	Stanwell Corp.	30	Feasibility study.
Starfish Hill	SA	Tarong Energy	up to 34.5	Starting construction, May 2002.
Toora	VIC	Stanwell Corp.	21	Under construction.
Cape Nelson	VIC	Novera and Wind Prospect	15	Feasibility study.

- **TASMANIA** – Hydro Tasmania has suggested that ultimately 1,000 MW or more of wind could be developed in Tasmania. The Tasmanian Treasury has indicated that, based on the European experience of 6m/s+ sites being commercially viable, there is the potential to construct in the order of 3,000 MW of wind generating plant in Tasmania.[41] Hydro Tasmania claims that this is contingent on Basslink going ahead.
- **SOUTH AUSTRALIA** – Development applications have been submitted for dozens of wind projects in South Australia.[42] Current wind farm proposals exceed 1,500 MW.[43]
- **VICTORIA** – Pacific Hydro has reportedly identified sites, a significant portion of which are in Victoria, for more than 2,000 MW of wind power.[44]
- **WESTERN AUSTRALIA** – While no assessment of the total wind resource in Western Australia appears to be publicly available, it is acknowledged that extensive sections near the coast experience high average wind speeds and Western Power has identified a number of sites suitable for large wind farms.[45]
- **NSW** – SEDA has estimated that there are over 1,000 MW of wind resources in NSW with an average wind speed of 6.5m/s or greater.[46]

THE COST OF THE ELECTRICITY PRODUCED FROM SUCH PROJECTS COULD BE AS LOW AS ABOUT $55 / MWh AT GOOD WIND SITES WITH A CAPACITY FACTOR OF 34%.

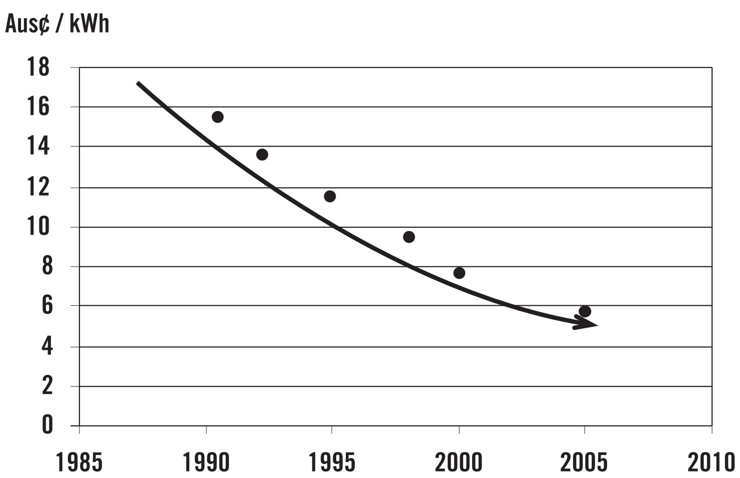
2.2.1.2 Relatively Low and Declining Costs

Wind energy costs have declined markedly over the past two decades (see Figure 3) and are among the lowest of renewable energy sources. At present, a prospective large-scale Australian wind farm (e.g. 100 to 200 MW) "can produce electricity at only 2 to 3 cents per kilowatt hour ($20 to $30 per MWh) more than the average generation prices in the National Electricity Market".[47]

Looking forward, wind project costs, including the equipment and its installation, the cost of leasing land, grid connections, developers' fees and other lesser charges, are estimated at under A$1,500 per kW for large developments proposed in southern Australia.[48] The cost of the electricity produced from such projects could be as low as about $55 / MWh at good wind sites with a capacity factor of 34%.[49] This is the middle of the range of estimated electricity prices in the National Electricity Market in 2010, when a cost for greenhouse gas emissions is included.

In considering these costs without a local manufacturing facility, it is important to recognise that Australian wind farm costs are currently highly dependent on the exchange rate because the largest component of a wind project's cost is the cost of the turbines themselves and all turbines are currently imported. Such factors influence the risk profile of projects and contribute to higher financing costs.

Figure 3 – US Wind Power Prices in Aus¢ / kWh - 1990 to 2010[50]



Several other factors indicate that wind energy costs should continue their decline, albeit at a decelerating rate:

- **Improving Technology / Scale Manufacturing** – The outlook for improved wind technology and manufacturing efficiency improvements remains strong. Larger unit sizes, more efficient blade design, advances in monitoring and controls and the increasing scale of manufacturing are all leading to efficiency gains. Above all, increased unit size has been a key factor in driving down costs. Germany's Enercon, for example, is developing a prototype 4.5 MW unit that is scheduled for initial deployment in 2003. This is far larger than the 1.8 MW of the largest units widely available currently and the 2.5 MW units now beginning to be deployed.
- **Larger Scale Deployment** – Larger wind farm project sizes should produce significant economies in:

  1. the costs of connection to the electricity network including extensions to the transmission networks when necessary;
  2. operations and maintenance;
  3. project development costs including gaining development approvals and landowner agreements; and
  4. financing.[51]

  Note that while larger project size brings significant economy, it can also raise or exacerbate land use issues and community concerns.
- **Better Financing Terms** – As the industry grows and becomes increasingly mainstream, the prospect of more favourable financing terms may also bring considerable cost declines. An indication of the increasingly mainstream nature of wind energy can be seen in the February 2002 entry of General Electric into the industry through its acquisition of Enron Wind.[52]

Overall, the American Wind Energy Association projected in 2001 that wind energy costs will fall by 35% to 40% by 2006.[53] This projection, while oriented to the US, is likely to apply globally due to the international nature of the industry and the technology. Similarly, *Wind Force 12* projects that wind prices will fall to US$26 / MWh by 2010 from about US$36 / MWh in 2001.[54]

Furthermore, growing demand for wind farms in Australia may enable local manufacturing and assembly, which in itself could lead to additional cost savings versus international pricing. Two proposals for separate Australian manufacturing facilities are already quite well advanced.[55]

2.2.2 Constraints on Wind Energy

While the cost, technical performance and resource of wind are all excellent, there are several potentially significant constraints that need to be considered. These include:

- transmission infrastructure issues;
- uncertain capacity value due to variable output;
- system operating issues at high penetration levels; and
- land planning considerations constraining otherwise suitable wind energy sites.

2.2.2.1 Lack of Transmission Infrastructure

Some prospective wind sites lack adequate existing transmission infrastructure. For example, the southern region of South Australia has excellent wind resources that may be able to support in excess of 1,000 MW. As it stands, there is currently not sufficient transmission capacity to handle such output. Notably, concern has been raised that current transmission policy in the National Electricity Market is inappropriate and presents a significant barrier to effective development of major wind farms in favour of coal. In particular, local generators such as wind farms are required to pay the cost of new local transmission infrastructure. In contrast, the proposed transmission interconnection between South Australia and NSW would be paid in regulated prices imposed on customers and not by the interstate generators who will use the infrastructure.[56] There is a related question of the appropriate treatment of network losses, and the manner in which those are borne by the wind generators.

Transmission costs are not linear. For individual projects, transmission connection and augmentation may add up to 25% to the total project cost.[57] However, this constraint should be solvable at relatively low cost, assuming the development of several large wind farms in a given region across which the expense is spread. A 10% MRET could actually assist in solving this potential constraint because it could be expected to increase the scale of wind projects in a given region and scale is the key to reducing the cost impacts of transmission upgrades.

2.2.2.2 Uncertain Capacity Value Due to Variable Output

Wind can vary by year, by season, by time of day, and from moment to moment.

Depending on the pattern of wind, production may or may not occur at high-value times (e.g. cold winter mornings and evenings, or hot summer afternoons when the electricity system is in tight supply).

Furthermore, even if the wind generally blows during high-value times, any inability to predict the availability of the resource with a high degree of accuracy reduces the effective capacity of the wind farm. For example, an excellent wind site may have a capacity factor of 40%, meaning that it does not operate continuously. In other words, the capacity factor is an actual average output of 40% of its maximum theoretical output. Accordingly, to meet peak demand requirements, it may still be necessary to install additional generation which can be rapidly brought into and out of operation, or dispatched. The extent of reduced value is speculative, but it is reasonable to expect that it would increase as wind becomes a larger percentage of the electric system.

2.2.2.3 System Operating Issues at High Penetration Levels

At high penetrations (eg. greater than 20% of total generation capacity), the variability of wind energy may create challenges for current power system operation. However, it is not envisioned that such high levels would be required under a 10% MRET and therefore this may not pose a significant constraint. In anticipation of potentially large volumes of wind generation, NEMMCO has recently identified a range of issues to be addressed regarding the impact on and integration into the electricity system, and embarked on a process to resolve them. This process is expected to lead to changes to NEMMCO's central dispatch facilities and procedures and changes to some Code provisions to better meet the needs of both the National Electricity Market and the wind generation industry.[58]

As wind farm output varies from moment to moment, other dispatchable generators on the electricity system need to increase or decrease their output to maintain a balance between supply and demand. Operating reserves are required as a contingency against a large generating unit (e.g. a 500 MW coal power plant) failing, and also to adjust to continuously varying demand.

Wind farms need not necessarily cause significant challenges at less than very high levels of penetration. However, at some level it would be necessary to change operating procedures to accommodate the natural variability of wind, perhaps by increasing the amount of operating reserves (generation that can increase or decrease output relatively quickly) that are available.[59]

At low penetrations of wind energy such as exists in Australia currently, this issue is negligible. At the levels envisioned under a 10% MRET (i.e. less than 20% of total

GROWING DEMAND FOR WIND FARMS IN AUSTRALIA MAY ENABLE LOCAL MANUFACTURING AND ASSEMBLY, WHICH IN ITSELF COULD LEAD TO ADDITIONAL COST SAVINGS VERSUS INTERNATIONAL PRICING.

generation capacity) the issue is unlikely to be a significant one. No changes to operating reserves have been required in California which has 1,600 MW of wind, constituting about 3% of that State's generation and well in excess of the largest operating units there. Similarly, wind supplies about 18% of electricity in Denmark, with plans to add further amounts.[60] While technical characteristics of electricity networks are site-specific, these examples suggest that moderately high levels of wind generation need not necessarily pose undue operating challenges.

5,000 MW of wind could be achievable in Australia without significant operational cost, assuming that wind penetrations of 20% of generation in a given region prove technically acceptable. Assuming an average capacity factor of 34% for good wind sites, the 5,000 MW of wind farms could supply about 15,000 GWh of RECs per year. This would be well in excess of the amount estimated to be developed to meet the first 9,500 GWh MRET and a significant contributor to a 10% MRET.

SUCCESSFULLY DEVELOPING WIND'S FULL POTENTIAL WILL REQUIRE CAREFUL EXAMINATION OF THE POTENTIAL IMPACTS OF EACH WIND FARM IN A MANNER CONSISTENT WITH EFFECTIVE COMMUNITY CONSULTATION AND STRATEGIC REGIONAL PLANNING.

2.2.2.4 Land Planning Considerations

Wind farms can have a variety of land use impacts that must be carefully evaluated and managed. These include impacts on flora, fauna, scenic values, noise, interference with radio, television signals and cultural heritage.

Many sites with excellent wind have land use issues that may limit the development potential. For example, a wind farm proposal near Cape Bridgewater in Victoria was denied planning approval in 1998 for a variety of reasons, including concerns over visual impact in an area of particularly high scenic value.[61] This may prove to be a significant constraint on future large scale wind farm development. In the UK and other parts of Europe, which have significantly higher population densities and far greater adoption of wind energy to date, land use issues have been an increasing constraint, with considerable attention now devoted to offshore wind farms.

Successfully developing wind's full potential will require careful examination of the potential impacts of each wind farm in a manner consistent with effective community consultation and strategic regional planning. This approach will be critical as more and larger proposals are developed.

2.2.3 Employment and Regional Development Aspects of Wind

Wind projects are generally located well outside urban areas. The major high value components of wind turbines are currently imported, although some components such as towers are already locally made. Roads, foundations and electrical works also bring local employment.

Vestas has announced its intention to develop a major assembly facility creating 50 jobs in Tasmania to supply Hydro Tasmania's Woolnorth Wind Farm. Additional manufacture of major high value components such as the rotor blades would produce another 250 jobs, if sufficient numbers of turbines are ordered.[62] Similarly, NEG Micon has committed to extensive local manufacturing in Victoria to supply Pacific Hydro with 400 turbines over five years, contingent on the approval of Portland Wind Farm.[63] Pacific Hydro reports that the result would be 90% local content, including nacelle assembly (the housing for the generator), tower manufacture, and blades, with 2000 direct and indirect jobs. Prospects for such local employment would benefit from a higher MRET.

Many countries are anticipating that their planned growth in wind projects will lead to new manufacturing centres going well beyond assembly and there are several precedents. For example, Vestas has announced its intention to build a turbine manufacturing plant in the US based on expected high demand there.[64]

Based on numbers from Australia's largest wind farm at the moment, the 21.6 MW Albany Wind Farm in WA, about 0.2 ongoing jobs are created for every 1 MW of installed capacity.[65] In addition, just over 100 job years were created in the manufacturing and construction of the farm.[66]

Assuming a 20 year life of the wind farm, these manufacturing and construction jobs equate to about 5 ongoing jobs or an additional 0.23 jobs per MW (0.23 jobs per MW = 100 jobs / 20 year life / 21.6 MW). Given that approximately half the value of projects is added in Australia for current projects, one might expect a doubling of the total manufacturing and construction employment to 0.46 jobs per MW should domestic manufacturing of turbines commence.

If 5,000 MW were to be installed in Australia, at a total of 0.66 on-going jobs per MW (0.2 in operation and 0.46 in installation and manufacture), this would be equivalent to at least 3,300 on-going jobs. It is particularly important to note that many of these jobs would be in rural and regional areas of Australia. The above employment figure excludes consideration of any indirect job multipliers which would be particularly valued in rural and regional Australia. In addition to standard spin-off employment arising in suppliers and from increased spending by employees, there are a number of unique indirect employment benefits of wind farms:

- wind farms have become tourist attractions in many locales around the world including Australia;
- wind farms provide another source of revenue to land holders and hence increase their viability; and
- Australia has significant potential to be a regional exporter of wind technology and expertise.

2.3 Solar Water Heating

Solar water heating (SWH) has the potential to be the most economic high volume source of new renewable energy in Australia. However, achieving the full economic potential of SWH would require significant institutional and policy changes as it is currently a minor niche product that has high costs due to low production volume.

2.3.1 Opportunities for Solar Water Heating

Solar water heating has several strengths:

- it uses well demonstrated, relatively mature technology;
- it is widely applicable in new and existing buildings; and
- it should, in high volume deployment, cost significantly less than the electric water heating it replaces, on a life cycle basis.

2.3.1.1 A Demonstrated, Mature Technology

Solar water heating is well demonstrated, with about 320,000 systems operating in Australia alone.[67] These systems produce about 3 MWh per year each,[68] or the energy equivalent of about 300 MW of wind farms, making SWH a leading renewable energy source today.[69] While current systems are used in only a small percentage of Australia's households, they provide ample evidence of strong technical performance.

Globally, SWH is used in over seven million households, including five million in Europe.[70] Most of Israel's 1.5 million households use solar water heating, which has been required by law in all new domestic buildings since 1980.[71]

While only a small fraction of households, outside of Israel and Greece, have SWH, the favourable performance of SWH is reflected by its growing role in national programs. For example, SWH is expected to make up the majority of households participating in the Million Solar Roofs program in the United States.

2.3.1.2 Wide Applicability of SWH

An individual SWH for a typical eligible household can create around 30 MWh of RECs at the time of installation under current MRET rules. The actual amount varies from household to household based on such factors as location (e.g. a SWH in Tasmania produces about 20%

KEY MRET RULES FOR SWH

A newly installed SWH is eligible to create RECs if:

- it is in a new building; or
- it is the first water heater installation in an existing building; or
- it replaces an existing electric water heater; or
- it replaces SWH that uses electric boosting; and
- the system is listed in the schedule to the regulations.

NUMBER OF RECS CREATED:

- the number is specified by the Office of Renewable Energy Regulator;
- the number of RECs is based on the estimated energy production over 10 years;
- the number varies by location, SWH model and whether a new or replacement installation;
- the RECs are granted in the year the SWH is installed (not granted year by year).

http://www.orer.gov.au/pubs/generators.doc less than one in Brisbane, all other things being equal), orientation of the roof, the occupants' hot water use patterns and the particular SWH model chosen. However, reasonable estimates of energy production based on typical usage patterns, SWH models, and location have been produced for the purposes of the existing MRET.[72] The MRET rules specify the eligibility and number of RECs that can be created by SWH.

More than any other OECD economy, SWH is well suited for most of Australia's households due to the large number of clear days and high average insolation. Many commercial buildings and institutions are also excellent SWH candidates.

About 60% of households in Australia use electric water heating and would be eligible to create RECs.[73] Assuming an average 12 year life for conventional water heaters, an estimated 700,000 replacements are installed annually in Australia, about 400,000 of which use electricity. SWH is technically feasible for the majority of households, but there are some constraints, such as shading from trees or neighbouring buildings, and lack of suitable roof space (e.g. in multifamily residences). Also, some high-rise properties have constraints on the amount of roof space that could be devoted to solar collectors.

There is no survey of the fraction of Australian households and commercial buildings for which SWH is feasible. Assuming that 85% of the annual electric water heater replacements can use SWH, it would produce about 10,000 GWh of RECs per year.[74]

In addition, about 100,000 to 150,000 new homes are built each year, all of which are eligible to use SWH to create RECs. New homes are particularly well suited to SWH, with opportunities for greater ease of installation and lower incremental costs relative to conventional water heaters. Installing SWH in 85% of these would produce about 4,000 GWh of RECs per year.[75]

Together, installation of SWH in new and replacement applications could total over 450,000 units per year, producing over 13,000 GWh of RECs annually by 2010.[76] This is far in excess of the approximately 1,000 GWh of RECs from SWH estimated for the first 9,500 GWh MRET.

TOGETHER, INSTALLATION OF SWH IN NEW AND REPLACEMENT APPLICATIONS COULD TOTAL OVER 450,000 UNITS PER YEAR, PRODUCING OVER 13,000 GWh OF RECS ANNUALLY BY 2010.

2.3.1.3 Prospects for Excellent SWH Economics

Solar water heaters inherently cost more to produce and install than conventional water heaters. Additional equipment is needed, such as the solar panels, roof mounting fixtures and, depending on the type of system, pumps and heat exchangers. Additional installation costs relate to placing the collectors, typically on the roof, and running additional piping.

It currently costs approximately $1,500 more to buy a common 300 litre SWH system compared to a comparable conventional water heater, (e.g. $2,600 for a 2 panel SWH compared to $1,100 for an electric storage water heater).[77] However, because of the energy cost savings, SWH can be beneficial for the consumer even without taking into account government rebates and the sale of RECs.

For example, consider the cases in Queensland and Tasmania, based on local solar conditions and electricity prices:

	QUEENSLAND	TASMANIA
Electricity Price, $ / kWh	$0.04939[78]	$0.08444[79]
Energy savings, MWh / year	3	2.4
Annual savings, $ / year	$150	$200
Present value of savings ($) based on 15 year life and real discount rate of 5%[80]	**$1550**	**$2100**

In the Tasmanian case, energy cost savings could justify spending up to $2,100 more for a replacement SWH, well in excess of the apparent actual cost increment of $1,500. The case in Queensland is also marginally favourable to SWH, although less so due to the lower cost of electricity there. The current case in NSW is slightly less favourable due to a lower off-peak electric water heater tariff. However, the NSW regulator has found that electricity prices for storage water heaters are below the cost of supplying electricity and has adopted a transition plan to increase those prices by 2004.[81]

While a 5% real discount rate is reasonable for assessing the economic merit of SWH, consumers tend to behave as if they have apparently far higher discount rates. Governments have attempted to overcome this behaviour with rebates, such as $500 per qualifying system in NSW, and the sales of RECs. For example, the sale of RECs may total about $750 for a typical system, based on the current offers of Energex and Western Power of $26 / REC.[82]

Significant cost reductions in installed SWH costs appear to be achievable even without any major technical developments. The largest single opportunity is through large-scale deployment, as opposed to the current niche market sales. Large-scale deployment would enable some economies of scale in manufacturing and significant economies in installation and in sales and marketing overheads.

Large-scale deployment,for example deployment in virtually all new household construction and in the majority of water heater replacements, might deliver reductions of 30% to 50% relative to current installed costs.[83] For example, one International Energy Agency bulk buying demonstration project was able to achieve cost savings of 30% for a project with only 100 SWHs.[84] In Israel, where SWH is ubiquitous, installed costs of an average system were reported at 450 to 640 ECUs in 1995, or less than $1,500 per system in 2002 dollars.[85]

LARGE-SCALE DEPLOYMENT MIGHT DELIVER REDUCTIONS OF 30% TO 50% RELATIVE TO CURRENT INSTALLED COSTS.

In sufficient scale, this could lead to an incremental installed cost relative to conventional electric water heating of well under $1,000. This would lead to excellent consumer benefits from SWH in most households, without government rebates, sales of RECs, or electricity price increases resulting from Australia's greenhouse commitments.

Further, there are several technology improvements in SWH that stand to improve cost and performance. For example, the United States Department of Energy's Solar Buildings program is in the midst of a multi-year US$10 million+ program aimed at reducing the installed cost of SWH by 50% by 2004. The primary approach being taken is to develop polymer materials to replace or reduce the use of glass, and metals in the solar collectors and piping. The benefit would be far lower materials and manufacturing costs, and lower shipping and installation costs due to the lighter weight.[86]

2.3.2 Barriers to Mass Deployment of SWH

While the cost, technical performance, and resource potential of SWH are all excellent, there are two primary barriers to mass deployment of SWH. These are:

- Consumer behaviour alone is unlikely to produce high SWH usage; and
- Achieving high deployment would be likely to require building or appliance energy performance standards.

2.3.2.1 Consumer behaviour alone is unlikely to produce high SWH usage

There are a number of significant barriers and behavioural constraints to the effective consideration and adoption of energy technologies by small consumers such as households (see Table 5). The existence of such barriers in energy efficiency decision making by small consumers has been widely recognised.[87]

Table 5. Barriers to Consumer Take-up of SWH

1) Consumer and building industry inertia (e.g. habits) and risk aversion in switching from status quo
- — low interest, as water heating is a small part of household spending;
- — general lack of consumer awareness.

2) Consumer and building industry uncertainty about cost and performance of SWH versus conventional water heating.

3) High consumer time commitment required to reduce uncertainty including time to understand relative cost savings and time relative to urgency of replacing a failed water heater.

4) Consumer, local government and social concerns of aesthetics of rooftop panels and tanks.

5) Financial barriers including limited investment capital available and higher initial cost of SWH.

6) Split incentives make recovering investment difficult (e.g. landlord invests, tenant benefits or homeowner invests but doesn't recover investment in house sale).

IF A MANDATE WAS GIVEN TO THE SWH INDUSTRY THAT EQUATED TO 450,000 SWH SYSTEMS PER YEAR, 6,000 PERMANENT JOBS WOULD BE CREATED.

Several of the barriers listed in Table 5 can be addressed and to some extent some of them are. For example, manufacturers are mitigating aesthetic concerns by developing models that are better integrated into roofs, and by producing systems that give the appearance of skylights.

Also, the MRET legislation has been successful in encouraging several energy retailers to develop SWH promotional programmes as a source of RECs.[88] These programmes can help by increasing consumer awareness, supplying information, providing financing, and generally facilitating the adoption of SWH.

However, these programmes necessarily still rely primarily on consumer behaviour and will be likely to capture only a portion of the potential. As a result, it is unreasonable to expect that SWH would be adopted in any degree approaching its full economic and technical potential if dependent primarily on consumer behaviour.

2.3.2.2 Achieving high deployment would be likely to require building or appliance energy performance standards

It is generally accepted in Australia and internationally that building and appliance energy performance standards can provide significant benefits to consumers and to an economy as a whole.[89] In most jurisdictions in Australia, however, there are no energy performance standards encouraging or mandating either the consideration or the use of SWH. Rather, decisions to consider SWH have been left primarily to consumer behaviour, as influenced by vendor marketing efforts.

However, there is a growing number of local councils (currently 42 in NSW) that now require consideration of low GHG emissions water heating (including SWH and gas water heaters) as a condition of building approvals. The first to take this approach was Leichhardt Council in NSW. Since 1994, Leichhardt Council has mandated SWH systems on new residential construction and redevelopments except where they are found to be unsuitable for specific reasons.[90] Internationally, Israel remains the exception in achieving near total deployment of SWH in building through the use of legal mandates.

There is, however, significant domestic and international precedent for mandating improved energy efficiency features in both appliances and building standards. At the national level, Australia has been developing increasingly comprehensive Building Energy Performance Standards and Minimum Energy Performance Standards for major energy using appliances and equipment over the last several years.

To date, opportunities to strongly promote SWH have not been incorporated in the Australian Building Code and Building Energy Performance Standards, nor is there an indication that such an approach is as yet under consideration either for the replacement market or for new construction.[91] However, given that there would be both a net consumer and net societal benefit to mandating SWH, there is a credible case for inclusion of SWH in the future.

2.3.3 Employment and Regional Development Aspects of SWH

While mass deployment of SWH is without precedent in Australia, an indicative employment picture can be constructed:

- **Manufacturing Employment** – Manufacturing of SWH equipment is reasonably labour intensive and involves some highly skilled manufacturing jobs. Currently, approximately 30 hours of manufacturing labour are required per SWH system.[92] Assuming labour efficiency gains of about 100% in mass market production volumes[93] leading to 15 hours of manufacturing labour per system, some 1000 manufacturing jobs per 100,000 systems of annual production could be created.
- **Installation Employment** – An average installation may take 5 person hours under mass market conditions. This represents an improvement of some 20% to 30% over current practice. Installation employment could be about 300 jobs per 100,000 systems of annual production.

Under the above scenario and, if a mandate was given to the SWH industry that equated to 450,000 SWH systems per year, 6,000 permanent jobs would be created.

2.4 Biomass Energy from New Multi-Benefit Revegetation Projects

Biomass energy crops are a highly prospective source of renewable energy in Australia. However, a number of biomass sources and processes which are eligible under MRET rules have raised significant environmental concerns and some are viewed as not truly renewable.

In weighing the benefits of biomass energy crops, issues of concern include use of wood waste from native forests, use of genetically modified organisms, loss of biodiversity, intensive fertiliser and pesticide use, soil loss for intensive energy crops and emissions of toxic compounds. Provided that these matters are satisfactorily addressed, biomass energy has significant potential as a truly renewable source of energy. One step to that end could be the use of independent third party certification such as by the Forest Stewardship Council.

A NUMBER OF BIOMASS SOURCES AND PROCESSES WHICH ARE ELIGIBLE UNDER MRET RULES HAVE RAISED SIGNIFICANT ENVIRONMENTAL CONCERNS.

Under the current 9,500 GWh MRET rules, a variety of resources defined as biomass waste have the potential to provide a large fraction of the required RECs. However, regardless of whether they are viewed favourably or not, the total existing biomass resource potential is limited relative to a 10% MRET.

If biomass is to be employed to meet a significant fraction of a 10% MRET, it is necessary to look beyond the existing biomass resources. Bioenergy crops, while technologically and commercially more speculative than existing biomass wastes, may have a relatively large technical potential. While single purpose bioenergy crops can appear relatively expensive, integrating energy production into other agricultural and plantation-related projects can reduce costs significantly.

One recent example of this is Visy's kraft pulping mini-mill at Tumut in NSW. It is a paper recycling facility for 60,000 tonnes per annum of waste paper and a processing facility for 240,000 tonnes of plantation wood fibre. It generates 75% of its own energy needs and is an accredited 17 MW renewable energy plant. It has not only led to the establishment of 30,000 ha of new plantations but may produce up to 15% of the nation's 2002 REC requirements. Its total output of 300,000 tonnes per annum could also eliminate Australia's imports of softwood pulp and help redress a $1.5bn annual balance of trade deficit in pulp and paper products.[94]

Another proposed project illustrates how large plantations can provide multiple products and revenue streams. AusPine has proposed that a 60MW plant be located at its 45,000 ha South Australian plantations near Mount Gambier. The energy plant would consume some 600,000 tonnes per annum of sawmill and forestry residues that currently go to waste.[95] The entire facility would continue to produce substantial sawn timber and woodchips in addition to the outputs of the new energy facility. It should be noted, however, that as a monoculture pine plantation with significant export woodchip production, this project may raise significant environmental concerns.

Much attention has been drawn to Australia's growing problem with water quality and salinity, which the Prime Minister has called "one of the three great challenges" facing the government of Australia.[96] Salinity poses risks to farming, water supplies, transport infrastructure and buildings, as well as harming remnant vegetation areas with important ecosystems. Australian governments have committed to spending $1.4 billion over seven years to develop salinity and water quality solutions.[97] While the solutions to the salinity problem are yet to be developed, it appears that plantations and farm forestry will play a vital role and therefore warrant particular attention.

2.4.1 Prospects for Multi-Benefit Revegetation Bioenergy

The prospect of multi-benefit bioenergy crops on a large scale is less certain than wind or solar water heating. However, it merits consideration for several reasons:

- existing technologies are mature, with opportunities for significant improvement;
- the resource is potentially very large; and
- the energy economics may be highly attractive given the multiple benefits.

2.4.1.1 Demonstrated Energy Conversion Technology

Biomass conversion in dedicated conventional steam boilers is technically mature. Over 14,000 MW of biomass generating capacity are installed worldwide, including 7,000 MW in the United States alone.[98]

A variety of advanced conversion technologies are being pursued with the aim of significantly increasing conversion efficiency and decreasing costs. For example, the US Department of Energy's Biomass Energy Program is pursuing advanced gasification, anaerobic digestion technologies that could achieve efficiencies of over 35%, considerably higher than the 25% typical in existing conventional boilers. While biomass energy is already competitive with other forms of renewable energy, projects such as these would enhance the prospects for relatively small scale bioenergy based on revegetation.

2.4.1.2 Large Potential Resource

Revegetation programs to mitigate dryland salinity could produce large amounts of biomass that may be suitable for bioenergy. Australia's dryland salinity problem is a result of the clearing of deep-rooted native vegetation, and replacement with shallow-rooted crops in areas with saline soils. Without the deep-rooted vegetation, the water table gradually rises, mobilising salt in the soil and bringing it to the surface.

OVER 14,000 MW OF BIOMASS GENERATING CAPACITY ARE INSTALLED WORLDWIDE, INCLUDING 7,000 MW IN THE UNITED STATES ALONE.

Given the vast areas affected by dryland salinity, there is a potentially large area of land that may be suitable for revegetation. Currently, about 5.7 million hectares suffer from or are at risk from dryland salinity in Australia.[99] This is approximately 12.4% of Australia's arable land.[100] With the continued gradual rising of water tables under cleared lands, the amount at high risk over the coming decades is estimated at over 17 million hectares (some 37% of total arable land).[101] Affected regions include the Western Australian wheat belt and Murray Darling basin in South Australia, Victoria, Queensland and New South Wales (see Table 5). The cost to the Australian economy of dryland salinity and degraded water quality is currently estimated at over $3.5 billion annually.[102]

Revegetation of affected areas with deep rooted plants is recognised as an important salinity mitigation strategy as it could halt or reverse rising water tables.[103] While the science of groundwater modelling and the mapping of salinity, vegetation and hydrology is rapidly progressing, there is as yet no comprehensive assessment of the location and extent of revegetation that would be required. A target of 15% revegetation of agricultural areas in Western Australian, including the wheat belt, has been set.[104] However, some estimates indicate that far more revegetation might be required, perhaps over 75% of affected areas.[105]

Table 6. Areas with High Dryland Salinity Potential (millions of hectares)

	2000	2050
NSW	0.2	1.3
Victoria	0.6	3.1
Queensland	Not assessed	3.1
South Australia	0.4	0.6
Western Australia	4.4	8.8
Tasmania	0.1	0.1
TOTAL	**5.7 million ha**	**17 million ha**

Source: "National Dryland Land and Water Resources Audit 2001"

THE COST TO THE AUSTRALIAN ECONOMY OF DRYLAND SALINITY AND DEGRADED WATER QUALITY IS CURRENTLY ESTIMATED AT OVER $3.5 BILLION ANNUALLY.

Even if the area that needs to be revegetated is only a quarter of the total 17 million hectares estimated to be at risk, the resulting bioenergy could potentially supply all of a 10% MRET. The amount of biomass suitable for energy production on any hectare of revegetation would vary with the type of vegetation, local conditions such as rainfall, current salinity levels, water table depth, and other uses of the vegetation.

The Integrated Wood Processing demonstration plant, currently under development in Narrogin, Western Australia, is one advanced example of a multiple benefit revegetation project which includes electricity production. The demonstration facility will use 20,000 tonnes per year of coppiced mallee biomass harvested from about 3,000 hectares of salinity management plantings at local farms. That biomass is projected to produce about 7,500 MWh per year (in addition to about 700 tonnes of activated carbon and 200 tonnes of eucalyptus oil).[106] The land area of plantings would be about 3,000 hectares,[107] suggesting electricity production of about 2.5 MWh per hectare per year for the project. Notably, the Narrogin project is designed to optimise the total value of a variety of outputs, rather than just maximise electricity output.

The amount of land that would ultimately be revegetated, and when, is necessarily speculative, as is the type of energy crop that may be applied. Assuming revegetation on 25% of the land area where the risk of dryland salinity is high, and electricity production rates similar to the Narrogin project, revegetation bioenergy could potentially produce over 10,000 GWh per year. The amount of energy production per hectare from a particular project will vary greatly due to factors such as species mix planted, rainfall, and the amount of biomass used for energy as opposed to other commercial uses. The bioenergy produced could be much higher – possibly as high as 42,000 GWh.

2.4.1.3 Potentially Attractive Economics Based on Multiple Benefits

Electricity from tree cropping has been identified as having potentially cost-competitive and commercially attractive prospects in low rainfall areas.[108] However, this will require considerable additional development of specialized production systems.

For example, an economic analysis of the Narrogin Oil Mallee project indicates that it should be capable of generating electricity for $60 / MWh even while yielding a high after tax return on investment of over 18%, with 100% equity financing.[109] Returns are achieved from the sale of high valued eucalyptus oil and activated carbon, as well as the electricity.

Notably, the Narrogin economic analysis did not include revenue from salinity management or other land care benefits, which could be large.

2.4.2 Challenges to Multi-benefit Revegetation Bioenergy

While the prospects for bioenergy from integrated revegetation projects are large, achieving the prospects will require addressing four primary challenges:

- demonstrating specialised production systems which bring low cost and high performance for multiple commercial products;

- the difficulty of implementation on this scale in the current timeframe;
- finding a way to integrate bioenergy with the broader scientific, technical and institutional challenges presented by dryland salinity management; and
- addressing environmental concerns about large scale plantations and broad-scale agriculture.

2.4.2.1 Demonstrating Cost-effective Multi-product Production Systems

Plantations that simultaneously produce wood products, paper products, renewable energy, carbon sequestration, salinity and biodiversity benefits are without precedent. However, the Tumut, Mt Gambier and Narrogin projects are demonstrating that facilities producing various combinations of these benefits can be both feasible and economically viable.

2.4.2.2 Large Scale Implementation

Revegetation projects of sufficient scale (e.g. many thousands of square kilometers) to produce significant quantities of renewable energy and other useful products would take time to plan, secure approvals for, and establish. What is more, trees mature slowly and useful outputs from revegetation projects may not be available for a number of years. For large scale revegetation projects to make a meaningful contribution to a 10% MRET target, an aggressive implementation approach would be required.

WHILE THE PROSPECTS FOR BIOENERGY FROM INTEGRATED REVEGETATION PROJECTS ARE LARGE, ACHIEVING THE PROSPECTS WILL REQUIRE ADDRESSING FOUR PRIMARY CHALLENGES.

2.4.2.3 Integrating Bioenergy with Salinity and Other Environmental Efforts

Large scale adoption of bioenergy as a salinity solution would require integration with current scientific and technical efforts. Bioenergy must demonstrate itself to be an integral part of the technical solution to salinity. Perhaps the greatest challenge, however, will be an institutional one because a variety of new economic instruments are needed to manifest the economic value of a wide variety of salinity benefits and carbon sequestration benefits.

While such instruments are without substantial precedent, the introduction of the MRET in Australia and similar legislation elsewhere demonstrates that turning environmental benefits into economic gain is readily achievable. There is also significant uncertainty about the long term level of effort and funding (or alternately, development of salinity-based market instruments) that will be devoted to addressing salinity, and the ability to tap these as revenues for multi-benefit bioenergy crops.

2.4.2.4 Addressing Environmental Concerns About Large Scale Plantations

Plantations, whether for biomass or other purposes, have raised a number of environmental concerns in the past. In the context of this study, particularly large scale plantations will be required both to be effective in redressing salinity and to ensure the economic viability of the processing facilities. Therefore, environmental considerations will need to be carefully addressed. These include:

- integrating plantations with other land use considerations including protection of existing natural vegetation;
- avoiding the use of mono-culture plantations;
- maximising the use of native species;
- avoiding the harmful use of chemicals; and
- independent third party certification.

2.4.3 Employment and Regional Development Aspects of Revegetation Bioenergy Facilities

While mass deployment of bioenergy facilities is without precedent, an indicative employment picture can be constructed based on existing data.

The US National Renewable Energy Laboratory reports that for every megawatt of forest residue and wood waste biomass electricity generation capacity installed, 4.9 jobs are created,[110] while an ACIL study for SEDA suggested a figure of 3.69.[111] At the Narrogin project, an estimated 40% of the jobs are attributable to the energy components of the project. This equates to 2.6 jobs per MW.[112]

Under the above scenario, some 1,300 MW of generation would be required to produce 10,000 GWh a year assuming a 90% plant capacity factor. At 3.7 jobs per MW, some 5,000 jobs would be created.

2.5 Photovoltaics and MRET

Photovoltaic (PV) energy is highly competitive in a number of specialist applications such as remote area (off-grid) power systems for households and communities, telecommunications, marine, public lighting and water pumping. It is also competitive in some relatively small on-grid applications, such as providing network support. The niches in which PV is competitive continue to grow. However, PV remains far from competitive for wholesale or retail electricity in grid-connected applications relative to conventional generation and other prospective large volume renewable sources such as wind, biomass or solar water heating.

Without technology breakthroughs, manufacturing at scale and supportive government policies, PV is likely to remain uncompetitive for the short-term. Accordingly, PV is likely to play a limited role in providing RECs in 2010 under the current MRET legislation, whether under a 9,500 GWh MRET or a higher 10% MRET. Interestingly, there is strong community support for PVs, reflecting that price is not the only driver for adoption of energy supply options.

2.6 Compliance by Penalty

Under the MRET legislation, liable parties have the option to comply by paying a penalty to the Australian Government in lieu of surrendering their share of RECs. That penalty is set in legislation at $40 / MWh, with no indexing for inflation. As the penalty is not tax deductible, it is equivalent to a pre-tax REC price of $57 at the Australian corporate tax rate of 30%.

Under a 10% MRET, the chances that compliance by penalty occurs is far higher than under the current 9,500 GWh MRET. Although the renewable energy sources discussed in this study could well produce the RECs needed for the 10% MRET, compliance by penalty payment may be an attractive outcome at times, particularly if there are plant production problems or if new production does not come on line quickly enough to meet the MRET requirements.

In addition to its role in ensuring compliance, the penalty serves an important secondary purpose in driving project developers to deliver less expensive renewable energy projects. From the perspective of a project developer, the penalty is essentially a competitor that they must beat on price. Also, because it is not indexed for inflation, the penalty puts ever increasing pressure on project developers to continue lowering costs as the years progress.

A benefit of the penalty is that it could provide a source of funding to the Australian Government to reinvest in renewable energy. For example, if renewable energy proves more expensive than anticipated, leading to revenues from MRET penalties, the Australian Government would be well positioned to devote additional funds to renewable energy R&D, recycle the revenue to those retailers that have surrendered RECs and fund specific renewable energy projects or other energy policies to improve longer term options.

LARGE SCALE PLANTATIONS WILL BE REQUIRED BOTH TO BE EFFECTIVE IN REDRESSING SALINITY AND TO ENSURE THE ECONOMIC VIABILITY OF THE PROCESSING FACILITIES. THEREFORE, ENVIRONMENTAL CONSIDERATIONS WILL NEED TO BE CAREFULLY ADDRESSED.

3. Conclusions

There is a strong case that new renewable energy sources could meet a 10% MRET of up to 36,500 GWh per year by 2010 at no or very low cost. Further, these sources would be likely to bring significant greenhouse gas emission reductions of some 26 million tonnes of CO_2 per yr and employment benefits of over 14,000 new jobs, a large portion of which would be in regional areas.

This outcome would depend on a host of factors involving a potentially high volume of the renewable energy technologies themselves. It would also depend on events in the conventional electricity sector, and on developments in international greenhouse gas policies. In particular, the prospect of international emissions trading, e.g. as envisioned under the Kyoto Protocol, could place significant value on the emission reductions that new renewable energy would deliver, thereby mitigating or negating the incremental cost of supplying RECs.

A large assortment of renewable energy technologies have been identified as likely to contribute to the existing 9,500 GWh MRET. Achieving a 10% MRET of up to 36,500 GWh, however, would require intensive development of other key sources. This study identified three prospects as particularly warranting attention:

- wind;
- solar water heating; and
- biomass from new multiple-benefit revegetation projects.

Each could potentially supply a large fraction of the additional 27,000 GWh that would be required. Critical challenges would need to be successfully resolved for each of these to meet their full potential, however. In the absence of the stimulus of a 10% MRET, these sources could still be developed (e.g. if there were a carbon tax or major salinity initiative). However, the additional stimulus of a 10% MRET would provide a clearer support for parties seeking to address the challenges and enhance their long term prospects as the 9,500 GWh target has shown.

Finally, it should be noted that any shortfall of new renewables would be met by payments made to the government in lieu of RECs. This source of government revenue could be used for a variety of purposes, such as additional renewable energy R&D, recycled to retailers who have surrendered RECs or used to fund specific renewable energy projects.

4. Appendix — Calculations

1. Calculations for Net Cost of RECs
Net cost of RECs = average cost of generating renewable electricity - incremental cost of displaced electricity (including the cost of CO_2 emissions).

2. Calculations for 2.2% and 3.5% growth
(MRET in 2010) = (forecast 2010 electricity generation) x (total 2010 renewable energy percentage) – (1997 base year renewable electricity generation);

where:

(total 2010 renewable energy percentage) = (1997 base year energy percentage) + (desired MRET percentage, e.g., 2%, 5% or 10%);

(total forecast 2010 electricity generation) = (2000 electricity generation) x (1+ forecast annual growth rate, e.g., 2.2% or 3%)^{10years};

2000 electricity generation = 193 million MWh; (ESAA 2001);

1997 base year renewable electricity generation = 16,000 MWh; (ESAA 2001)

1997 base year renewable electricity generation percentage = 10%; (ESAA 1998)

3. Calculations on greenhouse gas savings
27,000 GWh x 1000 MWh / GWh x 0.98 t / MWh = 26.46 million t

4. Calculations for average cost of delivery in 2010
The $58 is the volume-weighted average of all the sources (using the midpoint of $100 / MWh for the 'other' category), omitting the 1,600 MWh of old hydro.

5. Calculation for little or no net societal cost
Net cost of RECs = average cost of generating renewable electricity - incremental cost of displaced electricity (including the cost of CO_2 emissions).

6. Calculations on job figures
With 100 construction and manufacturing job-years for a 20 year life project, this means that after 20 years another 100 construction jobs would be required or an equivalent of 5 ongoing jobs in construction & manufacturing. Albany WF has 21.6 MW, so the 5 ongoing jobs in construction and manufacturing average to 5 jobs / 21.6 MW = 0.23 jobs/MW. Doubling this due to domestic manufacturing would give 2 x 0.23 = 0.46 jobs / MW.
In addition, there are 0.2 jobs / MW in ongoing O&M, so
total jobs / MW = 0.46 + 0.2 = 0.66.

7. Calculations for energy equivalent
3 MWh / year – SWH x 320,000 SWH x (1 GWh / 1000 MWh) = 960 GWh.

300 MW of windfarms with a capacity factor of 36% produces = 36% x 8760 x 300 MW * (1 GWh / 1000 MWh) = 946 GWh.

8. Calculation on replacing 85% of annual electric water heating systems
400,000 homes x 85% with SWH x 30 GWh RECs / SWH x (1 GWh / 1000 MWh) = 10,200 GWh, or about 10,000 GWh.

9. Calculation on SWH in 85% of new homes
140,000 homes x 85% x 30 MWh / SWH x (1 GWh / 1000 MWh) = 3570 GWh, or some 4000 GWh.

10. Calculation on GWhs produced by SWH
450,000 SWH / year x 30 MWh RECs / SWH x (1 GWh / 1000 MWh) = 13,500 GWh RECs, or some 13,000.

5. Endnotes

1 See Appendix – Calculation 3.

2 Renewable Energy Certificates (RECs) are a form of “currency” created by the Renewable Energy (Electricity) Act 2001 and used to demonstrate compliance with the requirements of MRET.

3 There are significant opportunities to cut projected demand growth. For example, the Electricity Supply Association of Australia has estimated that a “commitment by Federal, State and Territory governments to a substantially more effective national electricity end-use efficiency program” could potentially reduce demand in 2010 by about 9% from projected levels. Electricity Supply Association of Australia, *Strong Electricity Demand Continues*, 13 June 2002.

4 Electricity Supply Association of Australia, *Strong Electricity Demand Continues*, 13 June 2002.

5 McLennan Magasanik Associates, *Projections of Price of Renewable Energy Certificates to Meet the 2% Renewable Energy Target: Final Report to AGO*, 10 March 2000.

6 Australian Greenhouse Office, *Questions and Answers: Carbon Trading - Emissions Trading and Carbon Credits,* www.greenhouse.gov.au/emissionstrading/qanda.html.

7 National Institute of Economic and Industry Research, *Projections of independent power production, impacts of greenhouse policies and estimates of electricity price elasticities - a report for the National Electricity Market Management Company*, 28 January 2000.

8 See Appendix - Calculation 1.

9 Department of Agriculture, Fisheries and Forestry – Australia, *A National Action Plan for Salinity and Water Quality,* November 2001.

10 Unless otherwise specifically noted, this study discusses direct job creation. In addition to direct employment there would be a number of additional indirect jobs created. For example, *Wind Force 10: The Australian Contribution*, (Greenpeace / AusWEA, July 2001) found that 9,375 direct and indirect jobs would be created in producing 5,000 MW from wind. That is consistent with this study’s estimated 3,300 direct jobs for the 5,000 MW, and a multiplier of about 1.8 indirect jobs for each direct job.

11 Net cost of RECs, i.e. in excess of the $50 to $60 / MWh assumed cost of the incremental electricity sources displaced by the new renewable sources, which includes a $10 to $15 / MWh value for foregone CO_2 emissions.

12 Prime Minister of Australia, *Safeguarding the Future: Australia’s Response to Climate Change*, 20 November 1997.

13 Virtually all of the renewable electricity generation in 1996/97 was from large hydro-electricity projects, with very small amounts from biomass, primarily bagasse and black liquor, and wind.

14 Draft Statutory Instruments, *Electricity, England and Wales; The Renewables Obligation Order 2002*, http://www.dti.gov.uk/renewable/ro_order2002.htm.

15 Baker & McKenzie, *Air Regulation and the Power Sector*, 24 Sept 2001; Platts Global Energy, *Renewable Energy Schemes in the US*, http://www.platts.com/features/greencertificates/us.shtml.

16 See e.g. Australian EcoGeneration Association, Media Release 20 July 2001, www.ecogeneration.com.au.

17 Electricity Supply Association of Australia, *Electricity Australia 2001*, Table 4.2.

18 See e.g. Electricity Supply Association of Australia, *Electricity Australia 2001,* Table 2.7, which indicates about 2.2%; and Ian Nethercote, ESAA Chairman, “ESAA Perspective” in *Electricity*

Supply April 2002, who notes that meeting Australia's economic growth objectives would require about 3.5% annual electricity growth.

19 Note that the relationships between the MRET and the percentage growth rate and percentage target is nonlinear e.g. a 10% target is not equal to double a 5% target. This is because the MRET is defined as an *increment* in the percentage of renewable energy over the share of renewable energy in 1997.

20 See Appendix - Calculation 2.

21 Australian Greenhouse Office, *National Greenhouse Gas Inventory 2000 – Analysis of Trends,* 2002.

22 Australian Bureau of Statistics, *Survey of Motor Vehicle Use 2000*, 2001; Australian Greenhouse Office, *National Greenhouse Gas Inventory 1999*, April 2001.

23 McLennan Magasanik Associates, *Projections of Price of Renewable Energy Certificates to Meet the 2% Renewable Energy Target - Final Report to AGO*, 10 March 2000.

24 Australian Greenhouse Office, *Questions and Answers: Carbon* T*rading, Emissions Trading and Carbon Credits,*
www.greenhouse.gov.au.

25 National Institute of Economic and Industry Research, *Projections of independent power production, impacts of greenhouse policies and estimates of electricity price elasticities - A report for the National Electricity Market Management Company*, 28 January 2000.

26 *Ibid*.

27 Australian EcoGeneration Association, *RECs, Baselines and Industry Development*, July 2002.

28 Estimates for existing hydro based on Australian EcoGeneration Association, *RECs, Baselines and Industry Development*, July 2002; Estimates for other technologies adapted from *Projections of independent power production, impacts of greenhouse policies and estimates of electricity price elasticities - A report for the National Electricity Market Management Company*, prepared by the National Institute of Economic and Industry Research, 28 January 2000.

29 Redding Energy Management, *2% Renewables Target in Power Supplies Potential for Australian Capacity to Expand to Meet the Target*, Submitted to Australian Greenhouse Office, January 1999; Maclennan Magasanik Associates, *Projections of Price of Renewable Energy Certificates to meet the 2% Renewable Energy Target*, 26 November 1999.

30 See Appendix – Calculation 4.

31 See Appendix – Calculation 5.

32 American Wind Energy Association, *Global Wind Energy Market Report*, 2002, p. 7.

33 Based on project announcements in 2001/02 by Babcock and Brown, Pacific Hydro and Ausker.

34 Department of Industry, Tourism and Resources, *Australian Energy News*, March 2002, p.29.

35 American Wind Energy Association, *Global Wind Energy Market Report 2001*, 2002.

36 Government of India Press Information Bureau, *India Plans Addition of About 6,000MW to Wind Power Capacity Over Next Decade,* 2 April 2002; Reuters News Service, *France to spend 10 billion euros on boosting wind power*, 3 April 2002. British Wind Energy Association, Media Releases, March 2001 and February 2002.

37 *Ibid* and *Australian Energy News*, March 2002, p.29.

38 American Wind Energy Association, *10 Steps in Building a Wind Farm*, no date; NZ Energy Efficiency and Conservation Authority, *Wind Power Technologies*, June 1995; European Wind Energy Association and National Renewable Energy Laboratory.

39 Based on AGO, Australian Wind Energy Association web site data and recent proponent announcements.

40 Department of Industry, Tourism and Resources, *Australian Energy News*, March 2002, p. 29.

41 Department of Treasury and Finance, Tasmania, *The Development of Tasmania's Generation Sector*, www.treasury.tas.gov.au.

42 Department of Industry, Tourism and Resources, *Australian Energy News*, March 2002, p. 29.

43 Australian EcoGeneration Association, *EcoGeneration*, April/May 2002, p. 7.

44 Department of Industry, Tourism and Resources, *Australian Energy News*, March 2002, p. 29.

45 http://www.westernpower.com.au/our_environment/renewable_energy/wind/index.html.

46 http://www.seda.nsw.gov.au/ren_wind_body.asp.

47 http://www.pacifichydro.com.au/portland_wind.htm.

48 Based on project announcements in 2001 and 2002 by Babcock and Brown, Pacific Hydro and Ausker showing an average installed cost of at least A$1,500 / kW for 6GW of total capacity.

49 Assuming a 20 year life, a capacity factor of 34%, maintenance costs equalling 1% of capital cost and with a real average cost of funds of 7%.

50 American Wind Energy Association, *What are the factors in the cost of electricity from wind turbines?* 2000 http://www.awea.org/faq/cost.html. Assumes exchange rate of A$1 = US$0.52.

51 American Wind Energy Association, *The Economics of Wind Energy*, March 2002.

52 General Electric, *GE Power Systems' Proposed Acquisition Of Enron Wind Nears Completion*, Media Release, 12 April 2002; www.ge.com. This acquisition is subsequent to the collapse of Enron.

53 American Wind Energy Association, *Comparative Cost of Wind and Other Energy Sources*, June 2001.

54 European Wind Energy Association / Greenpeace, *Wind Force 12*, May 2002.

55 Pacific Hydro Media Release, 28 February 2002 http://www.pacifichydro.com.au; Hydro Tasmania Media Release, February 2002 http://www.hydro.com.au.

56 Australian EcoGeneration Association, "*Transmission Rules may Condemn Wind in SA*", *EcoGeneration*, Issue 11, April/May 2002.

57 Based on reports of ElectraNet costings quoted to the 115 MW project of Ausker on the Eyre Peninsula.

58 NEMMCO announcement, July 2002, www.nemmco.com.au.

59 National Wind Coordinating Committee, *Wind Energy Transmission and Utility Integration*, 1997.

60 European Wind Energy Association / Greenpeace, *Wind Force 12*, May 2002, p. 19.

61 Victorian Civil and Administrative Tribunal, [1999] VCAT PL 120.

62 Jim Bacon statement, 11 February 2002, www.premier.tas.gov.au; Vestas announcement, 7 February 2002; www.vestas.com.

63 Pacific Hydro Media Release, 26 February 2002.

64 Vestas, "Stock Exchange Announcement No 06/2002", 3 April 2002; www.vestas.com.

65 Australian EcoGeneration Association, *Jobs and Investment Potential of Renewable Energy: Australian Case Studies,* February 2002.

66 *Ibid.*

67 About 4.5% of households had SWH in 1999 (Australian Bureau of Statistics, *Themes- Energy*, 2 February 2001, www.abs.gov.au). The total number of Australian households in 1999-2000 was about 7.2 million (Australian Bureau of Statistics, *Australia Now – Housing*, 2002, www.abs.gov.au).

68 See http://www.orer.gov.au/pubs/rec_swh.doc which specifies the number of RECs created for each type of eligible water heater. Based on energy produced over a 10 year period, the values range around 25 to 35 MWh, or around 3 MWh per year.

69 See Appendix – Calculation 7.

70 IEA/OECD Caddett, *Large Scale Solar Purchasing: A Business Opportunity*, 1998.

71 Israel Ministry of Foreign Affairs, http://www.israel-mfa.gov.il/mfa/go.asp?MFAH0ara0, 1998.

72 See http://www.orer.gov.au/pubs/rec_swh.doc which specifies the number of RECs created for each type of eligible water heater.

73 Australian Bureau of Statistics, *Themes - Energy*, 2 February 01, www.abs.gov.au.

74 See Appendix - Calculations 8.

75 See Appendix - Calculation 9.

76 See Appendix - Calculation 10.

77 See Australian Greenhouse Office, http://www.greenhouse.gov.au/renewable/home/shw_cs_1.html and Whyalla City Council, *Solar Hot Water Rebate Scheme*, 21 March 2002, http://www.whyalla.sa.gov.au/enviro/energy.htm.

78 Energex, http://www.energex.com.au/for_home/tariff_information/tariffs_elec.html, 2002.

79 Water heater electricity rate from Aurora Energy, www.auroraenergy.com.au, 2002.

80 Based on the current real mortgage rates.

81 IPART, *Regulated Retail Prices for Electricity to 2004*, S 9-4, December 2000.

82 Energex offered $26 per REC created using SWH, for the quarter ending 31 March 2002. http://www.energex.com.au/environment/solar_certificates_calculating_recs.html; Western Power http://www.westernpower.com.au/our_environment/renewable_energy_certificates/.

83 International Energy Agency, Task 24, 1998, http://www.ieatask24.org/about.htm.

84 Solar Water Heater Campaign, Leiden, May 1999 http://www.ieatask24.org/case5.htm.

85 ESIF, *Solar Thermal Directory – Sun In Action*: *The Solar Thermal Market in Israel*, http://www.solar.ariadne-t.gr/market/israel.doc.

86 US DOE Office of Energy Efficiency and Renewable Energy, *FY 2003 Budget in Brief*, and *Detailed Budget Justifications, Energy & Water Development Appropriations/Renewable Energy Resources/Solar Energy/FY 2003 Congressional Budget*, 2002,http://www.mbe.doe.gov/budget/03budget/index.htm.

87 See e.g. *Mechanisms for Promoting Societal Demand Management*, prepared for IPART by Energy Futures Australia Pty Ltd, February 2002.

88 See e.g. Energex at http://www.energex.com.au/environment/solar_certificates_program.html; and Energy Australia at http://www.energy.com.au/ea/earetail.nsf/Content/SolarHotWater_YourHome.

89 See, e.g. Australian Greenhouse Office & Australian Building Codes Board, *International Survey of Building Energy Codes*, 2000, www.greenhouse.gov.au/energyefficiency/building.

90 Leichhardt Council DCP 17, 1994; DCP 2000.

91 See Australian Greenhouse Office, http://www.greenhouse.gov.au/energyefficiency/appliances/index.html.

92 Based on Redding Energy Management 1999 estimate of 270 SWH manufacturing jobs, estimated annual production of 15,000 systems per year and an employment year of some 1,600 hours.

93 Such an assumption appears to be consistent with the significantly reduced pricing achieved in the Israeli market.

94 http://www.affa.gov.au/ministers/tuckey/releases/98/98_13tu.html, http://www.tai.org.au/Publications_Files/Papers&Sub_Files/Regional%20Jobs.pdf.

95 Auspine press release, http://www.auspine.com.au/Company/Press%20Releases/GreenEnergyProject.htm, http://www.auspine.com.au/Downloads/ANE%20AusPower%20Fund%20BioMass%20Due%20Diligence%2019-09-01.pdf.

96 http://www.pm.gov.au/news/speeches/2001/speech1316.htm.

97 *Council of Australian Governments' Meeting Communique*, 3 November 2000, http://www.pmc.gov.au/docs/coag031100.cfm.

98 http://www.eren.doe.gov/biopower/basics/index.htm.

99 National Land and Water Resources Audit, *Australian Dryland Salinity Assessment 2000*, http://audit.ea.gov.au/ANRA/land/land_frame.cfm?region_type=AUS&region_code=AUS&info=sal_context.

100 Geoscience Australia at http://www.auslig.gov.au/facts/dimensions/compare.htm.

101 *Australian Dryland Salinity Assessment 2000*, supra n.99.

102 Department of Agriculture, Fisheries and Forestry – Australia, *A National Action Plan for Salinity and Water Quality*, November 2001.

103 *A National Action Plan For Salinity and Water Quality in Australia*, ibid.

104 WA Department of Premier and the Cabinet, http://www.sustainability.dpc.wa.gov.au/CaseStudies/OilMallee/OilMallee.htm.

105 Australian Energy News, *Mallee Power*, June 1999, http://www.isr.gov.au/resources/netenergy/aen/aen12/12mallee.html.

106 Western Power, www.wpcorp.com.au/our_environment/renewable_energy/biomass/narrogin/iwp.pdf.

107 Oak Ridge National Laboratory, *Prospects for Bioenergy from Short-Rotation Crops in Australia*, http://bioenergy.ornl.gov/pub/iea/baker.pdf.

108 *The Contribution of Mid to Low Rainfall Forestry and Agroforestry to Greenhouse and Natural Resource Management Outcomes,* prepared for the Australian Greenhouse Office and the Murray-Darling Basin Commission by a consortium from CSIRO Land and Water, CSIRO Forestry and Forest Products, Australian National University Department of Forestry, Rural Industries Research and Development Corporation, Olsen and Vickery (private consultants), Hester Gascoigne & Associates (private consultants), October 2001.

109 Rural Industries R&D Corp, November 2001, http://www.rirdc.gov.au/reports/AFT/01-160sum.html.

110 US Biomass R&D Initiative, November 2001, http://www.bioproducts-bioenergy.gov/1101.html.

111 NSW Sustainable Energy Development Authority, http://www.seda.nsw.gov.au/pdf/employmentindicators.pdf.

112 Australian EcoGeneration Association, http://www.ecogeneration.com.au/files/AEPG%20job%20study%20-%20stage%201%20rpt.pdf.

GREENPEACE CLIMATE REPORTS

Citizen Coal: Australia and its neighbours August 2002
How Australia's coal exports are locking developing Asian countries into a future based on greenhouse-polluting energy.
Greenpeace and the Mineral Policy Institute

When is a billion not a billion? September 2002
Analysis of the Howard Government's claims to have spent or allocated $1 billion on reducing climate change since 1997.
Written by Dr. Clive Hamilton of the Australia Institute

Wind Force 12 May 2002
A updated Blueprint to achieve 12% of the world's electricity from wind power by 2020. *Greenpeace and the European Wind Energy Association*

Solar Generation October 2001
Solar electricity for over 1 billion people and 2 million jobs by 2020. *Greenpeace and the European Photovoltaic Industry Association*

Wind Force 10 July 2001
A Blueprint to achieve 10% of the world's electricity from wind power by 2020 — The Australian Contribution.
Greenpeace, the Australian Wind Energy Association and the European Wind Energy Association.

The Stuart Oil Shale Project: Implications of carbon emissions constraints for Suncor Shareholders April 2001
Written for Greenpeace by international financial analysts, Innovest.

Faking It November 2000
A look at Australia's greenhouse policy and why Australia isn't addressing climate change.

Pacific in Peril October 2000
Biological, economic and social impacts of climate change on Pacific coral reefs. Written for Greenpeace by *Professor Ove Hoegh-Guldberg, Director, Centre for Marine Studies, University of Queensland.*

Climate Change, Coral Bleaching and the Future of the World's Coral Reefs 1999
Written for Greenpeace by *Ove Hoegh-Guldberg, Associate Professor, School of Biological Sciences, University of Sydney*.

Risking Australia October 1997
The impact of a changing climate

The Oil Industry and Climate Change August 1998
A Greenpeace Briefing

The Climate Time Bomb 1994
Signs of climate change from the Greenpeace Database

GREENPEACE

Greenpeace is an independent campaigning organisation which uses non-violent creative confrontation to expose global environmental problems and their causes. We research the solutions and alternatives to help provide a path for a green and peaceful future.

Greenpeace's goal is to ensure the ability of the Earth to nurture life in all its diversity.

Greenpeace organises public campaigns:

- For the protection of oceans and ancient forests
- For the phasing-out of fossil fuels and the promotion of renewable energies in order to stop climate change
- For the elimination of toxic chemicals,
- Against the release of genetically modified organisms into nature and
- For nuclear disarmament and an end to nuclear contamination.

Greenpeace has been campaigning against environmental degradation since 1971.

Greenpeace Australia Pacific Ltd.

Level 4, 39 Liverpool Street Sydney NSW 2000

Ph: +61 2 9261 4666

Fax: +61 2 9261 4588

GPO Box 3307 Sydney NSW 2001

www.greenpeace.org.au

greenpeace@au.greenpeace.org

ABN 61 002 643 852

Next Energy

Level 12, 220 George Street Sydney NSW 2000

Ph: +61 2 9251 4072

Fax: +61 2 9247 5103

rroy@nextenergy.com.au

Putting Renewables on Target — A 10% Mandatory Renewable Energy Target

October 2002

ISBN number 1 876221 16 x

For reviewing drafts of *Putting Renewables on Target*, thanks to:

Keith Tarlo (Institute for Sustainable Futures, University of Technology)

Sven Teske (Greenpeace Germany)

Dr. Karl Mallon (Transition Research)

Justin Sheppard (Cambiar)

Alan Pears (Sustainable Solutions Pty Ltd)

Peter Szental (SEIA)

Ric Brazzale (Australian Business Council for Sustainable Energy)

Rick Maddox (Aria Professional Services Pty Ltd)

Jeff Angel (Total Environment Centre)

Glen Klatovsky (The Wilderness Society)

Dermot Foley (David Suzuki Fouundation)

Tim Haigh.

Designed by Pulse Design ♻ Printed on 100% Recycled Paper