

## Renewables in electricity generation and Australian Government renewable energy programmes

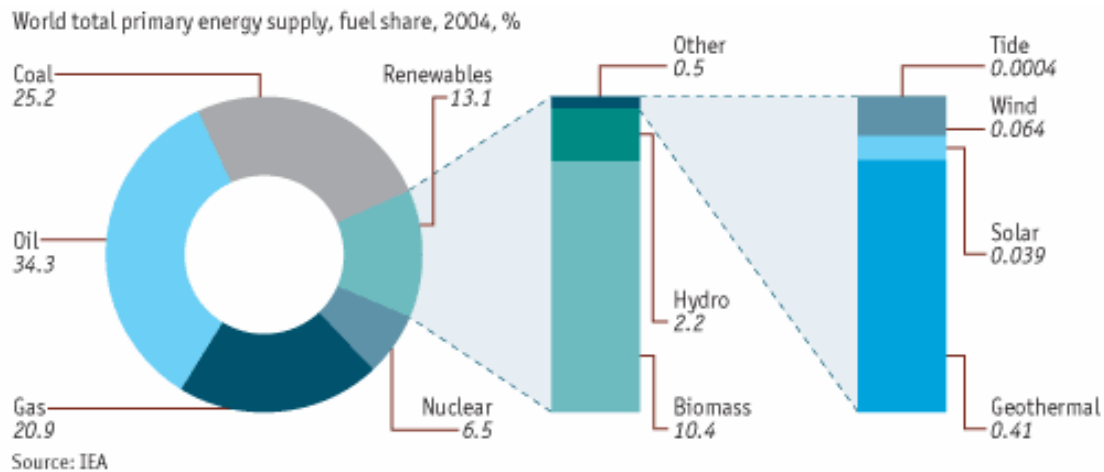
### **Renewables in primary energy supply and consumption**

- 2.1 The International Energy Agency (IEA) states that renewable energy sources contributed 13.1% of the world's total primary energy supply in 2004 (coal contributed 25.2% and nuclear power contributed 6.5%). Of the renewable contribution, biomass supplied 10.4% and hydro 2.2%. Solar and wind combined contributed 0.1% of primary energy supply, as depicted in figure 1.
- 2.2 At present, renewable energy in Australia accounts for less than 5% of total energy consumption. Renewable energy production is dominated by wood and woodwaste, bagasse (a waste product from sugar refining) and hydroelectricity (predominantly from Tasmania and the Snowy Mountains), which together accounted for 94% of renewable energy production in 2004–05. Biofuels (which include landfill and sewage gas) as well as solar and wind energy account for the remainder of renewable energy production in Australia. Most solar energy is used for residential water heating and this represents less than 1% of final energy consumption in the residential sector.<sup>1</sup>

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<sup>1</sup> K Donaldson, *Energy in Australia 2006*, ABARE, Canberra 2007, p. 69.

Figure 1 Fuel shares of world primary energy supply in 2004



Source IEA, *Renewables in Global Energy Supply*, 2007, p. 3; *The Economist*, 31 May 2007, on-line edition.

## Renewable energy sources in electricity generation

### Global outlook for electricity generation

- 2.3 The International Energy Agency (IEA) reports that (non-hydro) renewables generated 369 terawatt-hours (TWh) of electricity worldwide in 2004, with this quantity predicted to rise to 2 264 TWh in 2030, as shown in table 1. The IEA forecasts that, worldwide, the share of non-hydro renewable energy sources (which includes biomass, geothermal, solar, wind, tide and wave energy) in total electricity generation will increase from 2% in 2006 to almost 7% by 2030. The increase is projected to occur largely in OECD countries, though several developing countries are also adopting policies to increase use of renewables, such as China.
- 2.4 Wind power is predicted to achieve the biggest increase in market share, from 0.5% in 2006 to 3.4% in 2030. The share of electricity generation from biomass will increase from 1.3% to 2.4%. Geothermal power is predicted to grow at 4.5% per year and its share will increase from 0.3% to 0.5%. Solar, tidal and wave energy sources are forecast by the IEA to increase their contributions towards the end of the projection period.<sup>2</sup>

2 IEA, *World Energy Outlook 2006*, OECD/IEA, Paris, 2006, p. 144. Hydropower output is projected to increase at 2% per year on average over the period to 2030. The share of hydropower in total electricity generation is predicted to continue its downward trend, falling from 16% to 14%. Only about 31% of the economic potential worldwide had been exploited by 2004. Most new hydropower capacity is added in developing countries, where the remaining potential is highest. In the OECD, the best sites have already been

Table 1 World electricity generation to 2030 (by fuel type)

	Electricity generation (TWh)			Shares (%)			Growth (% p.a.)	
	2004	2015	2030	2004	2015	2030	2004 – 2015	2004 – 2030
Coal	6 917	10 609	14 703	40	43	44	4.0	2.9
Oil	1 161	1 195	940	7	5	3	0.3	-0.8
Gas	3 412	5 236	7 790	20	21	23	4.0	3.2
Nuclear	2 740	3 108	3 304	16	13	10	1.2	0.7
Hydro	2 809	3 682	4 749	16	15	14	2.5	2.0
Renewables	<b>369</b>	<b>986</b>	<b>2 264</b>	<b>2</b>	<b>4</b>	<b>7</b>	<b>9.3</b>	<b>7.2</b>
<i>Biomass &amp; waste</i>	227	422	805	1	2	2	5.8	5.0
<i>Wind</i>	82	433	1 132	0	2	3	16.3	10.6
<i>Geothermal</i>	56	100	174	0	0	1	5.5	4.5
<i>Solar</i>	4	30	142	0	0	0	19.7	14.5
<i>Tide &amp; wave</i>	1	1	12	0	0	0	9.1	12.4
<b>Total generation</b>	<b>17 408</b>	<b>24 816</b>	<b>33 750</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>3.3</b>	<b>2.6</b>

Source IEA, *World Energy Outlook 2006*, p. 493. Table shows IEA reference scenario.

- 2.5 In March 2007, the European Union (EU) set a binding target of 20% of energy consumption in member states from renewable sources by 2020 (nuclear capacity will also be taken into account when calculating the national commitments). The EU also set a 10% minimum target for use of biofuel in transport by 2020.<sup>3</sup>

## Projections for Australia

- 2.6 In 2004–05 a total of 252 TWh of electricity was generated in Australia, 93% of which was generated from fossil fuels (coal, oil and gas) and 7% from renewables (hydro, wind, biomass and biogas), as shown in table 2. Only 0.8% of total electricity was generated from non-hydro renewables (wind and biomass). The Australian Bureau of Agricultural and Resource Economics (ABARE) predicts that total electricity generation will rise to 408 TWh by 2029–30, an increase of 62% over the period and an average growth rate of 1.9% per year.<sup>4</sup>

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exploited and environmental regulations constrain new development. Most of the increase in hydropower in the OECD occurs in Turkey and Canada.

3 Reuters, 'EU moves on renewable energy', *Sydney Morning Herald*, 10 March 2007, p. 21; Australian, 'EU deal boost nuclear industry', *The Australian*, 12 March 2007, p. 13.

4 C Cuevas-Cubria and D Riwoe, *Australian Energy: National and State Projections to 2020–30*, Canberra, ABARE, 2006, pp. 3–4, 29–32.

2.7 ABARE predicts that there will be little change in the relative shares of electricity generated from fossil fuels or renewables over the projection period. The main projected change in the sector's fuel mix will be an increase in the share of electricity generated from gas, from 14% in 2004–05 to 23% in 2029–30, and a corresponding decrease in the share generated from coal, from 77% in 2004–05 to 68% in 2029–30. The share of renewables (including hydro) in electricity generation is projected to increase only slightly, to 8% (33 TWh) by the end of the projection period, up from 7% (19 TWh) in 2004–05. This represents projected growth of 2.3% per year to 2030. Non-hydro renewables will increase their share from 1.2% (3 TWh) in 2004–05 to 3.7% (15 TWh) by 2029–30.<sup>5</sup>

Table 2 Forecast for electricity generation in Australia to 2029–2030 (by fuel type)

	Electricity Generation						Average annual growth 2004–05 to 2029–30 (% p.a.)
	2004–05		2019–20		2029–30		
	TWh	% of total	TWh	% of total	TWh	% of total	
Black coal	141	56.0	180	52.7	207	50.8	1.5
Brown coal	53	20.9	64	18.6	72	17.7	1.3
Oil	4	1.4	4	1.1	4	0.9	0.3
Natural gas	36	14.3	66	19.4	92	22.6	3.8
<b>Total Renewables</b>	<b>19</b>	<b>7.4</b>	<b>28</b>	<b>8.2</b>	<b>33</b>	<b>8.1</b>	<b>2.3</b>
<i>Hydro</i>	16	6.4	18	5.2	18	4.5	0.5
<i>Biomass</i>	1	0.4	4	1.2	5	1.3	7.3
<i>Biogas</i>	0	0.1	2	0.6	2	0.5	8.2
<i>Wind/solar</i>	1	0.5	4	1.2	7	1.7	7.0
<b>Total generation</b>	<b>252</b>	<b>100</b>	<b>342</b>	<b>100</b>	<b>408</b>	<b>100</b>	<b>1.9</b>

Source ABARE, *Australian Energy: National and State Projections to 2029–30*, p. 29; ABARE, *Energy in Australia 2006*, p. 45.

2.8 Wind, biogas and biomass (mainly bagasse and woodwaste) energy are forecast to account for the majority of the increase in electricity generation from renewable sources in Australia over the outlook period. This expansion in non-hydro renewables is predicted to reflect falling investment costs and the impact of a number of favourable government policies.

5 The Australian Greenhouse Office maintains a data base and a map of the locations of all renewable energy generators in Australia, available online at: <<http://www.ga.gov.au/renewable/>>. The Australian Wind Energy Association also maintains a database of all wind energy projects in Australia, available online at: <<http://www.auswea.com.au/auswea/projects/projects.asp>>. A table of all renewable power generators in Australia by type is listed in K Donaldson, *Energy in Australia 2006*, ABARE, Canberra, 2007, pp. 72–75.

- 2.9 Wind currently generates 0.4% of total electricity and is projected to contribute 1.7% by 2029–30. Growth in combined wind power and solar photovoltaics (PV) is forecast to be 7.0% (and biogas 8.2%) a year, but all are from a small base.
- 2.10 Around 97% (5.4 TWh) of the estimated growth in wind energy over the period is projected to occur in Victoria, South Australia, Western Australia and Tasmania. More than 80% of the projected growth in the use of biomass for electricity generation is projected to occur in Queensland alone. Hydroelectricity generation is projected to grow only modestly over the outlook period, reflecting the limited availability of suitable locations for the expansion of large grid-based hydro generation. Most of the projected expansion in hydro capacity is expected to occur as existing equipment is upgraded. Table 3 lists the capacity of renewable electricity generation in Australia in 2005.<sup>6</sup>

Table 3 Capacity of renewable electricity generation in Australia, 2005

State	Biogas (MW)	Bagasse (MW)	Wood waste (MW)	Other biofuels <sup>a</sup> (MW)	Hydro (MW)	Wind (MW)	Solar (kW)	Other <sup>b</sup> (kW)
NSW	42	16	45	4	3 957	16	839	500
Vic	24		0	34	649	104	214	
Qld	15	394	17	2	666	12	10	80
SA	26		4		2	318	100	20
WA	22	6	5	0	32	119	20	
Tas	0				2 265	68		
NT	1				0		825	
<b>Australia</b>	<b>130</b>	<b>416</b>	<b>71</b>	<b>40</b>	<b>7 571</b>	<b>637</b>	<b>2 008</b>	<b>600</b>

Source ABARE, *Energy in Australia 2006*, p. 70.

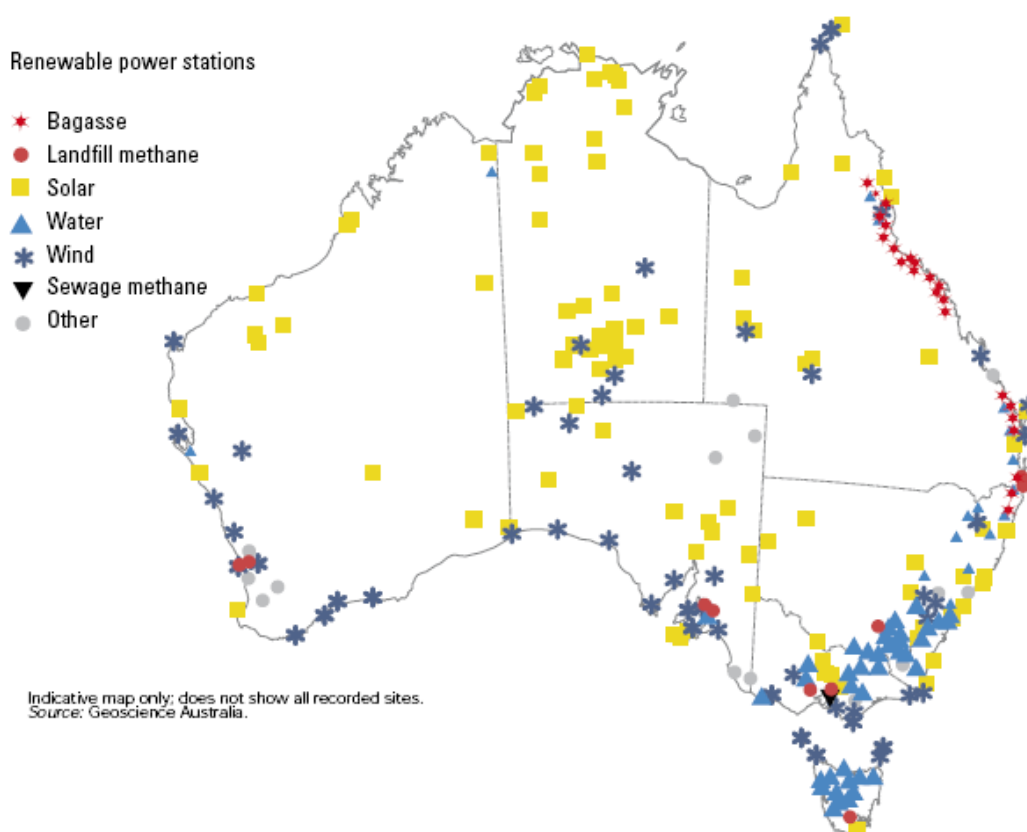
<sup>a</sup> Black liquor, plant and animal waste

<sup>b</sup> Ocean wave (NSW) and geothermal (Qld and SA)

- 2.11 The locations of Australia’s major renewable energy power stations and their type are depicted in figure 2.

<sup>6</sup> See also: Office of the Renewable Energy Regulator, *Annual Report 2006*, Australian Government, Canberra, 2007, pp. 10–13.

Figure 2 Australian renewable power stations



Source ABARE, *Energy in Australia 2006*, p. 76.

## The Australian electricity supply industry

- 2.12 The Australian electricity supply industry is comprised of the following sectors: generation, transmission, distribution and the retail sale of electricity.
- 2.13 Electricity is delivered to the user as follows: a power plant generates electricity which then passes through a transformer that converts the electricity from low to high voltage (i.e. greater electrical pressure) to enable its efficient transport on the transmission system. The transmission lines carry electricity long distances. When the electricity arrives at the location where it is required, a substation transformer changes the high voltage electricity to low voltage for distribution. Distribution lines then carry low voltage electricity to consumers who access it through the power outlets in homes and work places.
- 2.14 The National Electricity Market (NEM) began operating as a wholesale market for the supply of electricity to retailers and end-users in Queensland, New South Wales, the Australian Capital Territory, Victoria and South Australia in December 1998. Tasmania

- joined the NEM in 2005. Operations are currently based on six interconnected regions that largely follow state boundaries. The NEM supplies electricity to 7.7 million customers and approximately \$8 billion of energy is traded through the NEM each year, while total electricity sales to customers approach \$100 billion per year.
- 2.15 The National Electricity Market Management Company Ltd (NEMMCO) was established in 1996 to administer and manage the NEM, develop the market and improve its efficiency. The key parameters for NEMMCO's operation of the NEM are: the management of power system security; power system reliability and maintenance of a supply reserve (see the glossary for definitions of these terms). Exchange between electricity producers and consumers is facilitated through a pool where the output from all generators is aggregated and scheduled to meet demand.
- 2.16 Under its statutory rules, NEMMCO may *not* favour one fuel source over another. Consequently, NEMMCO has neither the power nor the authority to make decisions based on considerations of sustainability and environmental management. The various state regulators ensure that environmental impact assessments are conducted as part of any power industry planning initiatives.
- 2.17 Assets that comprise the NEM's infrastructure are owned and operated by state governments, and some are owned and operated under private business arrangements. As of 2005, the ownership share of assets in each sector was: generation (36% private and 64% public); transmission (43% private and 57% public); distribution (50% each); and retail (45% private and 55% public).<sup>7</sup>
- 2.18 From mid 2005, the Australian Energy Market Commission (AEMC) and the Australian Energy Regulator (AER) were given the responsibility for oversight and regulation of the NEM.<sup>8</sup>

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7 NEMMCO, *An Introduction to Australia's National Electricity Market*, NEMMCO, Melbourne, 2005, viewed 13 March 2007, <<http://www.nemmco.com.au/nemgeneral/000-0187.pdf>>.

8 Further information on the AEMC available at: <<http://www.aemc.gov.au/>>. Further information on the AER available at: <<http://www.aer.gov.au/content/index.phtml/tag/aerAboutUs/>>.

## The Australian Government's renewable energy policies and programmes

- 2.19 The Australian Government has provided support for renewable energy through measures under the Prime Minister's 1997 *Safeguarding the Future* Statement, the 1999 *Measures for a Better Environment* Statement, the 2004 Energy White Paper, *Securing Australia's Energy Future*, and initiatives contained in the 2007 Budget. These measures are summarised below.

### The Mandatory Renewable Energy Target

- 2.20 Introduced in 2001, the Mandatory Renewable Energy Target (MRET) is underpinned by the *Renewable Energy (Electricity) Act 2000* legislation. The MRET scheme aims to increase renewable energy electricity generation and is a key element underpinning the strategic development of the renewable energy industry in Australia. The measure uses a system of tradeable certificates and requires the generation of 9 500 GWh of additional renewable electricity by 2010, over and above existing renewable energy generation, and the maintenance of this target until 2020. This is enough power to meet the residential electricity needs of four million people, equivalent to a city the size of Sydney. The measure is expected to stimulate \$3 billion of investment in renewable energy over the life of the scheme. The Government reaffirmed its commitment to MRET in the Energy White Paper.<sup>9</sup>

### Energy White Paper measures

- 2.21 In the 2004 Energy White Paper, *Securing Australia's Energy Future*, the Australian Government allocated \$700 million for new initiatives to support low emission and renewable energy technologies, including:
- A \$500 million *Low Emission Technology Demonstration Fund* (LETDF), which will leverage at least \$1 billion in private sector investment in new technologies to demonstrate low emission technologies, including renewable energy, with significant long-term abatement potential.<sup>10</sup>

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9 Further information on the MRET scheme is available from the Australian Greenhouse Office at <[www.greenhouse.gov.au/markets/mret](http://www.greenhouse.gov.au/markets/mret)> and the Office of the Renewable Energy Regulator <[www.orer.gov.au](http://www.orer.gov.au)>.

10 Information on this programme is available at <[www.greenhouse.gov.au/demonstrationfund](http://www.greenhouse.gov.au/demonstrationfund)>.



- A \$100 million *Renewable Energy Development Initiative* (REDI) to support the development of renewable energy technologies with strong commercial potential.<sup>11</sup>
- A \$75 million *Solar Cities* trial, which will demonstrate the economic benefits of photovoltaics combined with other measures in reducing energy demand during peak periods.<sup>12</sup>
- A \$20.4 million *Advanced Electricity Storage Technologies* (AEST) initiative to support energy storage for intermittent renewable technologies, such as wind and solar.<sup>13</sup>
- Up to \$14 million to develop an *Advanced Wind Forecasting Capability*.
- An *Improving Grid Accessibility* initiative, whereby the Australian Government will work with the States and Territories to identify, and respond to specific rule changes required in the NEM to maximise the benefits of distributed generation.<sup>14</sup>

## Renewable energy programmes

2.22 Since 1997, the Government has allocated over \$300 million to renewable energy programmes, including:

- A \$26.9 million *Low Emissions Technology and Abatement* (LETA) programme to encourage ongoing investment in the development, demonstration and deployment of smaller-scale low emission technologies, and other cost-effective abatement activities.<sup>15</sup>
- A \$51.8 million *Photovoltaic Rebate Programme* (PVRP) which provides cash rebates to householders and community groups that install photovoltaic systems (expanded in the 2007 budget, as listed below).<sup>16</sup>

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11 Information on this programme is available at <[www.ausindustry.gov.au](http://www.ausindustry.gov.au)>.

12 Information on this programme is available at <[www.greenhouse.gov.au/solarcities](http://www.greenhouse.gov.au/solarcities)>.

13 Information on this programme is available at <[www.greenhouse.gov.au/renewable/government.html](http://www.greenhouse.gov.au/renewable/government.html)>.

14 Information on this initiative is available at <[www.mce.gov.au](http://www.mce.gov.au)>. Further information on the Energy White Paper is available at <[www.dpmc.gov.au/publications/energy\\_future](http://www.dpmc.gov.au/publications/energy_future)>.

15 Information on this programme is available at <[www.greenhouse.gov.au/leta](http://www.greenhouse.gov.au/leta)>.

16 Information on this programme is available at <[www.greenhouse.gov.au/renewable/pv](http://www.greenhouse.gov.au/renewable/pv)>.

- A \$26.6 million *Renewable Energy Equity Fund* (REEF) to provide support to smaller companies undertaking innovative Australian renewable energy technology projects.<sup>17</sup>
- A \$205 million *Renewable Remote Power Generation Programme* (RRPGP) which provides rebates to install renewable energy technologies in remote areas to reduce the use of diesel fuel for electricity generation. In August 2006, the Prime Minister announced a further \$123.5 million over four years for the RRGP.<sup>18</sup>
- A \$55.6 million *Renewable Energy Commercialisation Programme* to assist the commercialisation of innovative renewable energy technologies and support industry development projects.<sup>19</sup>

2.23 Since 2000, the Australian Government has also provided grants valued at over \$27 million from various programmes to support geothermal energy projects.<sup>20</sup>

## The Renewable Energy Action Agenda

2.24 In 2000, the renewable energy industry and the Australian Government developed the *Renewable Energy Action Agenda* (REAA). The REAA outlined a strategic vision and plan of action for the growing renewable energy industry, aiming to achieve annual sales of \$4 billion by the year 2010. Achievements to date in the implementation of the REAA have included:

- the formation of a peak industry body – the Australian Business Council for Sustainable Energy (BCSE);
- completion of a Renewable Energy Technology Roadmap and an Australian Photovoltaic Industry Roadmap;
- a trade mission organised by the Australian Renewable Energy Export Network to Brazil, Chile and Mexico in April 2002;
- the development, implementation and accreditation of renewable energy training programmes; and

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17 Information on this programme is available at <[www.ausindustry.gov.au](http://www.ausindustry.gov.au)>.

18 Information on this programme is available at <[www.greenhouse.gov.au/renewable/rrpgp](http://www.greenhouse.gov.au/renewable/rrpgp)>.

19 Information on this programme is available at <[www.greenhouse.gov.au/renewable/recp](http://www.greenhouse.gov.au/renewable/recp)>.

20 For example, on 27 August 2007, the Australian Government announced a \$3 million grant under the REDI initiative to support research into geothermal energy in South Australia to be undertaken by Torrens Energy Ltd. See: The Hon Ian Macfarlane MP, Minister for Industry, Tourism and Resources, '3M for SA Geothermal Energy Project', *Media Release*, 27 August 2007.

- the organisation of solar house days over the last four years by the Australian and New Zealand Solar Energy Society (ANZSES) to increase community awareness and commitment to renewable energy.<sup>21</sup>

## 2007 Budget measures

2.25 The 2007 Budget contained the following measures to address climate change:

- \$43.6 million over four years to establish a new CSIRO Climate Change Adaptation Flagship programme;
- \$32.5 million over five years to support multilateral initiatives in climate change adaptation and mitigation in Asia;
- \$18.5 million over five years for incentives for reducing methane emissions from coal mines;
- \$59.6 million over four years to accelerate the production of greenhouse friendly fuels;
- \$23.6 million over four years to provide tax deductions for businesses involved in planting forests as carbon dioxide sinks, for the dedicated purpose of reducing greenhouse gas emissions;
- \$123.5 million over four years to support the replacement of diesel-powered electricity generation and water pumping systems with renewable energy;
- \$197 million over five years for the Global Initiative on Forests and Climate, which is intended to assist developing countries to manage and maintain their tropical forests. Partnerships will also be established with developing countries to support energy efficiency and alternative energy initiatives;
- \$18.5 million over four years to develop and implement the legislation and regulatory regime for offshore carbon capture and storage;
- \$53.3 million over five years to provide information to households and small businesses about energy efficiency and reducing emissions;
- \$150 million over five years to fund an expansion of the Photovoltaic Rebate Programme (from the current \$4 per Watt to \$8 per Watt, up to a maximum of \$8 000), which is intended to

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21 Further information on the REAA is available at <[www.industry.gov.au/reaa](http://www.industry.gov.au/reaa)>.

increase the total number of rooftop solar systems to the equivalent of 40 000 homes by 2012; and

- \$7.9 million over five years to phase out the use of inefficient light bulbs.<sup>22</sup>

## International measures

2.26 The Australian Government is participating in a number of international fora to promote renewable energy. These include:

- The Asia Pacific Partnership for Clean Development and Climate (AP6), which has established a Renewable Energy and Distributed Generation Task Force, chaired by the Republic of Korea and co-chaired by Australia. The role of the Task Force is to develop detailed action plans outlining both immediate and medium-term specific actions. The Australian Government has announced a commitment of \$100 million over five years to the AP6, with 25 per cent allocated specifically for renewable technology projects.
- The Renewable Energy and Energy Efficiency Partnership (REEEP) which fosters international collaboration to accelerate the growth of markets in the use of renewable energy and energy efficiency technologies.<sup>23</sup>
- The International Energy Agency Implementing Agreements, which provide the basis for interested parties to collaboratively undertake energy technology research, development and deployment activities.<sup>24</sup>
- The Asia-Pacific Economic Cooperation Energy Working Group projects, which seek to maximise the energy sector's contribution to the region's economic and social well-being, while mitigating the environmental effects of energy supply and use.<sup>25</sup>
- Bilateral climate change partnerships currently in place with China, the European Union, Japan, New Zealand and the United States which expands the capacity for climate change action by providing market opportunities for greenhouse technologies, products and expertise from Australia, and broadens the participation in climate

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22 Australian Government, *Protecting Australia's Future: Environment Budget Overview 2007-08*, Department of the Environment and Water Resources, Canberra, 2007, viewed 22 June 2007, <<http://www.environment.gov.au/about/publications/budget/2007/ebo/index.html>>.

23 Further information is available at <[www.reeep.org](http://www.reeep.org)>.

24 Further information is available at <[www.iea.org/Textbase/techno](http://www.iea.org/Textbase/techno)>.

25 Further information is available at <[www.apec.org](http://www.apec.org)>.

change action by encouraging direct involvement by industry,  
business, scientists and communities.<sup>26</sup>

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26 Further information is available at  
<[www.greenhouse.gov.au/international/partnerships](http://www.greenhouse.gov.au/international/partnerships)>.

