

References

- ABARE 2002, *Australian energy consumption by industry and fuel type, energy units*. Table B1.
- ABARE 2002, *Australian energy supply and disposal, energy units*. Table H.
- ACIL Tasman 2003, *SRMC & LRMRC of generators in the NEM: A report to the IRPC and NEMMCO*.
- AGO 2002, *Australia's Third National Communication on Climate Change*, a report prepared under the United Nations Framework Convention on Climate Change, Canberra: Australian Greenhouse Office.
- Australian Business Council for Sustainable Energy (BCSE) 2003, *Driving Energy Efficiency*, Melbourne, November.
- Australian Greenhouse Office 2003, *National Greenhouse Gas Inventory 2001*, Canberra: Australian Greenhouse Office.
- Australian Government 1992, *National Strategy for Ecologically Sustainable Development*, AGPS, Canberra, December.
- Azar C, Lindgren K, Larson E, Möllersten K & Yan J 2003, Carbon capture and storage from fossil fuels and biomass – Costs and potential role in stabilizing the atmosphere, Preprint of conference paper available from Department of Physical Resource Theory, Chalmers University of Technology, Göteborg University, 412 96 Göteborg, Sweden. email: frica@fy.chalmers.se. (Submitted for publication.)
- Bailie A, Bernow S, Castelli B, O'Connor P & Romm J 2003, *The Path to Carbon Dioxide-Free Power: Switching to Clean Energy in the Utility Sector*, A study by Tellus Institute and Center for Energy and Climate Solutions for World Wildlife Fund, USA, April, see www.worldwildlife.org/powerswitch/power_switch.pdf
- Bartle JR 2001, New perennials crops: mallee eucalypts, a model large-scale perennial crop for the wheatbelt. In *Managing Agricultural Resources 3*, proceedings Outlook Conference 2001 ABARE, Canberra pp 117-128.
- Bauen A, Woods J & Hailes R 2003, *Bioelectricity Vision: Achieving 15% of Electricity from Biomass in OECD Countries by 2020*, study prepared for WWF International, November.
- Blakers A & Diesendorf M 1996, A scenario for the expansion of solar and wind generated electricity in Australia, *Aust. J. Environmental Management* 3:11-26.
- Bradshaw J, Bradshaw BE, Allinson AJ, Nguyen V & Spencer L 2002, The potential for geological sequestration of CO₂ in Australia: preliminary findings and implications for new gas field development, *APPEA Journal*, 42 (1):25-46.
- Bureau of Industry Economics 1992, *Recent Developments in the Theory of Economic Growth: Policy Implications*, Occasional Paper 11, BIE, Canberra
- Cabinet Office 2002, *The Energy Review*, Report by the Performance and Innovation Unit of the British Cabinet Office, February (www.piu.gov.uk/2002/energy/report/)
- Costello P 2002, *Intergenerational Report: 2002-03*, Budget Paper No. 5, Commonwealth of Australia, Canberra.

- Dao D, Ross S & Campbell R 1993, *Structural Change and Economic Growth*, Background paper No. 28, EPAC, Canberra.
- Davison J, Freund P & Smith A 2001, *Putting carbon back in the ground*, UK: IEA Greenhouse Gas R&D Programme, pp.20-22. Downloadable from www.ieagreen.org.uk; go to 'Capture & Storage of CO₂'.
- Department of Industry Science and Resources, Energy Efficiency Best Practice Program 2000, *Energy efficiency best practice in the Australian aluminium industry*, Canberra.
- Department of Trade and Industry 2003, *Our Energy Future – Creating a Low Carbon Economy*, Energy White Paper, UK Department of Trade and Industry, Version 11 on www.dti.gov.uk/energy/whitepaper/
- Department of Trade and Industry 1999, *New and Renewable Energy Prospects for the 21st Century*. See www.dti.gov.uk
- Dickson A, Akmal M & Thorpe S, 2003, *Australian energy: National and state projections to 2019-20*, ABARE eReport 03.10, abareconomics, Canberra
- Diesendorf M 2003, Australia's polluting power: Coal-fired electricity and its impact on global warming, Sydney: WWF Australia. 12pp. See www.wwf.org.au
- Dixon TF and Bullock GE 2003, Outlook for bioenergy in the Australian sugar industry. In S. Schuck (ed), *Bioenergy Australia 2003 Conference Proceedings*.
- EMET Consultants and Solarch Group 1999, *Baseline Study of Greenhouse Gas Emissions from the Commercial Buildings Sector with Projections to year 2010*, Australian Greenhouse Office, Canberra.
- Enecon Pty Ltd 2002, *Wood for alcohol fuel: Status of technology and cost/benefit analysis of farm forestry for bioenergy*. JVAP Bioenergy Series No. 1, Rural Industries Research & Development Corporation, Canberra.
- Enecon Pty Ltd 2003, *Wood for alcohol fuel: Status of technology and cost/benefit analysis of farm forestry for bioenergy*. JVAP Bioenergy Series, Rural Industries Research & Development Corporation, Canberra.
- Energy Efficient Strategies with assistance from Energy Partners and George Wilkenfeld & Associates 1999, *Study of Greenhouse Gas Emissions from the Australian Residential Building Sector to 2010*, Australian Greenhouse Office, Canberra.
- EPAC 1986, *Directions for Improved Long-Term Growth*, Council Paper No. 8, January, EPAC, Canberra
- ERDC 1994, *Biomass in the Energy Cycle*, final report, September.
- ESAA 2003, *Electricity Australia 2003*, Sydney: Electricity Supply Association of Australia Ltd.
- ESD, 1991, *Ecologically Sustainable Development Working Groups, Final Report, Energy Production*, AGPS, Canberra, pp 96-98.
- Foran B and Crane D 2002, Testing the feasibility of biomass based transport fuels and electricity generation. In *Australia. Australian Journal of Environmental Management* 9:44-55 (June). For more detail see the original 1999 technical report: <http://www.cse.csiro.au/research/program5/publications/99-07.pdf>

Freund P and Davison J 2002, General overview of costs, *IPCC workshop on carbon dioxide capture and storage*, Regina, Canada. Web: www.climatepolicy.info/ipcc/index.html

Geoscience Australia (2002), *Oil and Gas Resources of Australia 2001*, Canberra: Geoscience Australia.

Green MA 2003, *Green energy visions: personal views on the future of photovoltaics*, UNSW.

Greene D & Pears A 2003, *Policy Options for Energy Efficiency in Australia*, ACRE Policy Committee.

Hall C, Tharakan P, Hallock J, Cleveland C & Jefferson, M 2003, Hydrocarbons and the evolution of human culture, *Nature* 426:318-322.

Harmelink M, Graus, W, Blok K & Voogt M 2003, *Low Carbon Electricity Systems: Methodology & Results for the EU*, World Wide Fund for Nature.

Howe J. 1993, *Australia's growth potential in the 1990s*, Background paper No. 35, EPAC, Canberra.

HSBC 1999, Australia's industrial structure: In *The New Australian Economy*, *HSBC Economics*, 1H 1999, pp25-33.

IEA 2002, *World Energy Outlook 2002*, International Energy Agency.

IEA 2002, *Renewables in global energy supply*, fact sheet, International Energy Agency, see www.iea.org.

IEA 1999, *The Evolving Renewable Energy Market*, International Energy Agency, see www.iea.org/pubs/studies/files/evoree99/binnenwe.pdf

Interlaboratory Working Group 1997, *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy-Efficient and Low-Carbon Technologies by 2010 and Beyond*. Oak Ridge, TN and Berkeley, CA: Oak Ridge National Laboratory and Lawrence Berkeley National Laboratory. ORNL-444 and LBNL-40533. September. Apparently no longer available in Web.

Interlaboratory Working Group 2000, *Scenarios for a Clean Energy Future*, Oak Ridge, TN: Oak Ridge National Lab.; Berkeley, CA: Lawrence Berkeley Lab.; and Golden CO: National Renewable Energy Lab. ORNL/CON-476, LBNL-44029 and NREL/TP-620-29379, November. Available on <http://www.nrel.gov/docs/fy01osti/29379.pdf> (6 MB file).

International Hydro Association 2003, The Role of Hydropower, In, *Sustainable Development*, IHA White Paper, February, www.hydropower.org/.

IPCC 2001a, *Climate Change 2001: Synthesis Report*, Synthesis of the Third Assessment Report, Intergovernmental Panel on Climate Change, United Nations Environment Program/World Meteorological Organisation, Cambridge UK: Cambridge University Press.

IPCC 2001b, *Climate Change 2001 Working Group III: Mitigation*, Intergovernmental Panel on Climate Change, United Nations Environment Program/World Meteorological Organisation, Cambridge UK: Cambridge University Press, see Summary for Policymakers paragraph 17 and Chapter 5.

- Jonathan Fisher, Blyth W, Collings S, Boyle S, Wilder J, Henderson G & Grubb M 1998, *Prospects for Energy Saving and Reducing Demand for Energy in the UK*. London: Paper prepared for the Royal Commission on Environmental Pollution as background to the Study on Energy and the Environment.
- Kelleher FM 1997, Grains for gain: The potential for biomass harvest from crop residues in Australia. In S. Schuck (ed), *Biomass Taskforce Symposium Proceedings*, 21/10/1997.
- Lovegrove K et al. 2003, Paraboloidal dish solar concentrators for multi-megawatt power generation. ISES Solar World Conference, Goteborg, Sweden, June 2003.
- Lovegrove K et al, 2003, Developing ammonia based thermochemical energy storage for dish power plants, *Solar Energy* (in press)
- Marsh G, Taylor P, Anderson D, Leach M & Gross R 2003, *Options for a Low carbon Future – Phase 2*, report to UK Department of Trade & Industry.
- Martin B, Diesendorf M 1983, 'The economics of large-scale wind power in an optimally mixed CEGB electricity grid', *Energy Policy* 11: 259-266.
- Martin B, Diesendorf M 1982, 'Optimal mix in electricity grids containing wind power', *Electrical Power & Energy Systems* 4 (3):155-161.
- MacGill I, Watt M and Passey R 2002, *The economic development potential and job creation potential of renewable energy: Australian case studies*. Commissioned by Australian Cooperative Research Centre for Renewable Energy Policy Group, Australian Ecogeneration Association and Renewable Energy Generators Association.
- Ministerial Council on Energy 2003, *Towards a National Framework for Energy Efficiency – Issues and Challenges*, discussion paper. A joint initiative of Australian Federal, State and Territory Governments, November.
- Mintzer I, Leonard J A & Schwartz P 2003, *US Energy Scenarios for the 21st Century*, Pew Center on Global Climate Change
- MMA 2002, *Incremental electricity supply costs from additional renewable and gas-fired generation in Australia*, McLennan Magasanik Associates for Origin Energy Ltd.
- Music FM 1997, Final report European Commission Project RENA CT94 008.
- National Appliance and Equipment Energy Efficiency Program 2003, *Projected Impacts 2000-2020*, Canberra: Ministerial Council on Energy Report No. 2003/02.
- Naughten B, Pakravan P, Dlugosz J & Dickson A 1994, *Reductions in greenhouse gas emissions from the Australian energy system: a report on modelling experiments using ABARE's MENSA model*, ABARE, Canberra
- Nicholas ID & McGuire DO 2003, *A review of short rotation crops(SRC) environmental and economic externalities – Australasian implications*, Bioenergy Australia 2003 Conference, Sydney.
- National Office for the Information Economy 2003, *Australia's Information Economy*, National Office for the Information Economy, Canberra.
- Outhred H 2003, *Wind Energy and the National Electricity Market with Particular reference to South Australia*, report to Australian Greenhouse Office

- Pupilli S 2002, *Energy Efficiency Improvement Potential and Policies in the Commercial Sector*, Paper prepared for ABARE Energy Efficiency Workshop, December 2002, Canberra.
- RCEP 2000, *Energy – The Changing Climate*, report from the Royal Commission for Environmental Pollution, UK (see www.rcep.org.uk/energy.html)
- Redding G 2002, *Where is renewable energy going in Australia?*, ESAA 8th Renewable and Sustainable Power Conference.
- Riedy C & Diesendorf M 2003, Financial subsidies to the Australian fossil fuel industry, *Energy Policy* 31:125-137.
- Riedy C 2003, unpublished discussion paper available on www.isf.uts.edu.au.
- Schipper L, Unander F, Marie-Lilliu C, Walker I, Gorham R, Murtishaw S, Ting, M, Khrushch M & Krackeler T 2001, *Energy use in Australia in an International perspective: comparison of Trends through the mid 1990s*, OECD/IEA.
- Short C and Dickson A 2003, *Excluding technologies from the Mandatory Renewable Energy Target*, ABARE eReport 03.12, AbareEconomics, June, Table 10.
- Sinclair Knight Merz 1997, *Cogeneration Ready Reckoner Manual*, Canberra: Commonwealth Department of Primary Industries and Energy.
- Sinclair Knight Merz 2001, *A Review of the Viability of Cogeneration in Australia*, Commonwealth Department of Industry Science and Resources and Australian Ecogeneration Association.
- Sørensen B 2000, *Renewable Energy*, Academic Press.
- Standards Australia 1990, *National plumbing and drainage code: Part 4: Hot water supply systems*, AS 3500.4 – 1990.
- Standards Australia 1994, *Solar water heaters - domestic and heat pump - Calculation of energy consumption*, AS 4234 – 1994.
- Tedesco L and Thorpe S 2003, *Trends in Australian energy intensity: A report for the Ministerial Council on Energy*, ABARE eReport 03.10, abareconomics, Canberra.
- Turton H 2002, *The Aluminium Smelting Industry: Structure, market power, subsidies and environmental impact*, Canberra: The Australia Institute.
- Turton H, Ma J, Saddler H & Hamilton C 2002, *Long-Term Greenhouse Gas Scenarios*, Discussion Paper No. 48, The Australia Institute, Canberra
- Watt M & Outhred H 1999, *Energy Industry Sustainability: Policy Options*, ACRE, Murdoch W.A.
- Western Power, AusIndustry, Australian Greenhouse Office, Enecon & Oil Mallee Co. c2002, *Narrogin bioenergy plant: demonstration of integrated wood processing*, factsheet, downloaded from http://www.westernpower.com.au/html/about_us/environment/renewable_energy/renewable_bioenergy.html
- Zauner R (Sinclair Knight Merz) 2003, *New entrant prices and wholesale price projections, 2003*. Powerpoint presentation to EUAA.

Appendix A: External costs of fossil fuels

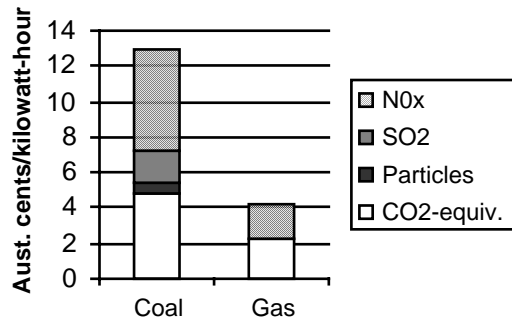
If we consider the environmental and health damage caused by the production and use of fossil fuels, the economic value of efficient energy use and renewable energy sources may be further increased. In recent years there has been much progress in the analysis of the *external* costs (costs of environmental and health damage that are not taken into account in the market prices) of energy supply in the US and EU. These costs are based on the full fuel cycles, e.g. from the mining of coal through to the disposal of fly ash from a coal-fired power station. They also trace all the main pathways of the pollutants from the points of emission to the various receptors (people, soils, crops, forests, buildings, etc.). The most comprehensive and recent set of studies is the ExterneE project carried out in 1998 on behalf of the European Commission.

There is of course much uncertainty in such calculations and the 1998 ExterneE studies can be considered to be very cautious and conservative, because:

- They evaluate only a limited range of greenhouse impacts and focus on the impacts of the well-known air pollutants, oxides of nitrogen and sulfur, to which they add the impacts of fine particles and aerosols which became pollutants of concern in the mid-1990s. They omit health hazards that they cannot quantify, such as those of heavy metals, VOCs, fluoride, land degradation and waste management.
- They consider only the impacts of the most modern combined-cycle power stations, with flue gas desulfurization (i.e. collection of SO₂ emissions from smokestacks), electrostatic precipitators (to collect dust from smokestacks) and low NO_x emissions. They point out that, for existing power stations, the emissions of NO₂ and SO₂ can be several times higher.
- They calculate the value of deaths from air pollution by multiplying the reduction of life expectancy by the value of life per year. Most earlier studies obtained much higher values by multiplying the number of deaths by the value of statistical life.

With these assumptions, ExterneE's calculated external costs of fossil-fuelled power stations, as reviewed by Rabl and Spadaro (2000), are shown in Figure A.1. To convert the results from Euro cents to Australian cents per kilowatt-hour of electricity generated, we have assumed that A\$1 = 0.56 Euro. These results are intended to be added onto the existing economic costs of electricity generation from fossil fuels.

Figure A.1: Typical damage costs of new baseload coal and gas-fired power stations assuming average European conditions



Compared with these results for fossil fuels, the ExternE studies find that the external costs of wind power, photovoltaic electricity and well designed biomass energy technologies are negligible.

The application of these European results to Australia is controversial, because exposure to sulfur dioxide and other air pollutants from power stations is much less here than in Europe and North America. So it could be argued that the European results should be scaled down to the lower population densities found in Australia. On the other hand, the ExternE studies omitted many pollutants and considered only the most efficient combined-cycle power stations, which do not exist among Australian coal-fired stations. So it is possible that the European results describe approximately the *present* situation in Australia. This can only be resolved by detailed measurements and calculations.

In applying the ExternE results to Australia in Fossil Case B (Section 10.2), we tentatively adopt the ExternE greenhouse costs and add to this one-quarter of the ExternE estimate of the air pollution costs.

Appendix B: Can renewable energy replace coal when demand is growing rapidly?

Coal-burning provides about 84% of Australia's electricity generation. Coal-burning makes by far the largest contribution to Australia's greenhouse gas emissions in millions of tonnes (Mt) of CO₂ and also in terms of Mt CO₂ per unit of electricity generated. Coal-burning is a big contributor to air and water pollution and land degradation. And coal mining is one of the three most dangerous occupations. Any sustainable development pathway must grapple with the nettle of reducing coal use through a combination of using energy more efficiently and supplying energy with much cleaner energy sources.

Some people argue that, since emissions from coal power stations in Australia are rising an order of magnitude faster than they can be currently reduced by renewable energy, we should only address the causes of rising demand and forget about renewable energy.

This argument is fallacious. While it is true that the absolute growth of renewable energy generation is currently much less than the absolute growth in coal-fired generation in Australia, the *percentage* growth rate in renewable energy, especially wind power, is much higher than that of coal. It is essential to keep in mind the properties of exponential growth. Even though renewable energy has started from a small base, it is growing globally each decade by a factor of about 10.

For example, Australian wind energy capacity was only 104 MW at the end of 2002, but at 25% per annum, assuming no constraints, it would reach 20 GW in 2025, substituting for a lot of coal along the way. With a more modest growth rate of 20% p.a. it would reach 20 GW around 2030 and at 15% p.a. it would reach 20 GW around 2040. For comparison, ABARE (2001, Fig. 12) assumes that wind power will grow at a rate of 25.2% p.a. from 1998-99 to 2019-20.

Therefore, to substitute for a substantial proportion of coal burning, we must maintain a high rate of growth in renewable energy capacity *and* implement efficient energy use.