

Meeting Global Challenges
12th APEC Women Leader's Network Meeting,
Port Douglas, 24-27 June 2007
Climate Change – The Role for Engineers

Global warming and its impact on climate change now dominates all discussion on environmental issues by government, industry and households. The Stern Review has stated “Climate change is global in its causes and consequences and international collective action will be critical in driving an effective, efficient and equitable response on the scale required”. Global warming is caused by greenhouse gas emissions (GHG), mainly carbon dioxide, and the main culprits are power generation and transport although there are a wide range of other industries that emit greenhouse gases. Engineers have an important role in addressing the many complex policy and technological issues relating to climate change.

Engineers Australia “Policy Statement on Climate Change and Energy” (Engineers Australia 2007) states that the role of engineers is to “lead capacity building to innovate for more sustainable, eco-efficient and less polluting outcomes in engineering practice”. Engineers are the key group of professionals with the requisite skills and have a vital role in developing and implementing technologies and adapting current technologies and engineering practices to reduce GHG emissions and in advocating for government policies to address climate change.

Engineers Australia concurs with the Stern Review (2006) that climate change is an economic, environmental and social problem. The Stern Review has indicated that the effects of our actions now on future changes in climate have long lead times. What we do now will have a limited effect on the climate in the next 40 to 50 years. However actions in the next 10 to 20 years will profoundly affect the climate in the second half of the century:

- § Actions to reduce emissions must be viewed as essential to mitigate the risks of severe consequences in the future. climate change threatens the basic elements of life for people around the world – access to water, food production, health and use of the land and environment;
- § A temperature rise of just 2 to 3 deg. C. rise within the next 50 years (expected if there is stabilisation in GHG emissions) will result in catastrophic effects including melting glaciers, rising sea levels, damage to eco-systems and declining crop yields;
- § The damage from climate change will accelerate as the world gets warmer;
- § The impact of climate change is unevenly distributed – the poorest countries and people will suffer earliest and most;
- § GHG emissions have increased with economic growth however the environmental impact of these emissions remain uncoded; yet stabilisation of these emissions is feasible and consistent with continued growth;
- § Current levels of GHG are equivalent to 430 parts per million (ppm) carbon dioxide (CO_{2e})¹ compared to 280ppm before the Industrial Revolution. This has caused the earth to warm by approximately 1 deg. C. The current level of emissions will increase CO_{2e} to 550 ppm by 2050. At this level the global temperature rise is expected to be 2 deg. C. If GHG emissions continue to increase, global temperatures are expected to rise by more than 5 deg. C. in the following century with potentially catastrophic consequences. The Stern Review recommends stabilisation of emissions to around 550ppm CO_{2e} by 2050, a target that balances the cost of reducing GHG emissions with the environmental benefits;

¹ The total radiative effect of greenhouse gases is quoted in terms of the equivalent concentration (in parts per million - ppm) of carbon dioxide and includes the six greenhouse gases described in the Kyoto Protocol but excludes gases such as ozone, CFCs and aerosols. The CO₂ equivalence is defined more fully in the Stern Review (2006).

- § The Stern Review estimates that the cost of stabilising emissions to 500-550ppm CO_{2e} is likely to be around 1% of GDP, a cost that could be borne by most developed economies without major disruption;
- § Three elements of policy for mitigation are: a carbon price, technology policy and removal of barriers to behavioural change.

There is growing international consensus on the broad framework to tackling climate change. The most important is to set the long term target related to the stabilisation level chosen for CO_{2e} and medium-term targets which define the pathway to achieving this target. The target sets the appropriate price for carbon - explicitly through tax or trading or implicitly through regulation. This will lead individuals and businesses away from high-carbon goods and services to invest in low-carbon alternatives and will make a whole range of alternative technologies competitive. Setting targets is very important in providing certainty for businesses that have to make long term investments in alternative technologies.

The Stern Review has recommended a stabilisation target of 500-550ppm CO_{2e} which would require government policies which provide medium term reduction targets of between 60 to 80 percent reduction in GHG emissions by 2050. Many countries in the European Union will achieve this target, demonstrating that it is achievable even in a highly industrialised country. Sweden was the first country to introduce the carbon tax of US\$100 per tonne in 1991, resulting in a dramatic restructuring of electricity generation and the development of clean technology industries. Sweden now leads the world in bio-fuels technology and is close to phasing out the use of imported heating oil².

The choice of policy will vary between countries and may be a mix of tax, trading and regulation. Trading schemes can effectively equalise carbon prices across countries and sectors. For example, the EU Emissions Trading Scheme (EU 2003) is the centrepiece of the European efforts to cut emissions. Effectively, the cap in GHG emissions sets the price of carbon which will provides returns on investments in low emission technologies. This “Cap and Trade” system has been recommended for Australia and is likely to be adopted around the world (See Table 1). This sets limits on greenhouse gas emissions for the economy as a whole and issues tradeable emissions permits up to this limit each year. Businesses must hold enough permits to allow them to emit their specified amount of GHG. If they adopt new technologies that reduce these emissions, they can sell the excess “credits” to other industries that have been unable to reduce their emissions below the set targets. It is the “cap” that produces the scarcity and therefore a price for the GHG emission permit or “carbon credit”. This creates an economic incentive for technology research, development and deployment and promotes adaptation of existing technologies, an area in which all engineers have an important role to play.

Power Generation

Emissions from the power sector are responsible for 24% of total GHG emissions of which 50% are consumed in residential and commercial buildings and 33% by industry including chemical refineries (Stern Review 2006). The power generating sector will need to be 60% decarbonised by 2050 to achieve the target of 550ppm CO_{2e} by 2050. In this sector, the higher the price of carbon, the higher the swing towards low or no-carbon intensity sources of power. Alternative technologies in power generation include: nuclear power, clean coal technologies, carbon capture and storage (both vital to the coal industry in Australia), biomass, geothermal, solar and wind power and all are currently more expensive than conventional fossil-fuel alternatives.

Currently coal fired electricity can be generated at \$30-\$40 per MWh using black or brown coal. Using combined cycle gas turbines, electricity can be generated at \$38-\$54 per MWh. A \$20 - \$30 per tonne carbon price³ makes alternative technologies viable. Clean coal technologies, such as super critical and

² Over the last six years, Swedish emissions have been an average of 3.7 per cent below 1990 levels. GDP has grown by around 25 per cent over the same period, see EPA Sweden (2007).

³ Prices are quoted as an illustration of how the carbon price will make alternative technologies viable. These are subject to change depending on various factors. Current price on the Chicago Climate Exchange is US\$3.20 per tonne of CO₂. See CCX (2007).

ultra super critical coal with post combustion capture can cut carbon emissions by 20%, cost \$64-\$108 per MWh but could drop to \$40-\$45 per MWh with improved technology, making them financially acceptable. Carbon capture and storage technologies will take at least 15 years to develop and will need a carbon price of \$20-\$30 per tonne to make it financially viable to retro-fit existing coal-fired power stations. Nuclear power, at a cost of \$40 - \$65 per MWh will also become viable at a higher carbon price. These examples illustrate that alternative technologies will only become viable if there is an appropriate carbon price for the adverse impact of GHG emissions to the environment.

Renewable energy sources are currently more expensive but improvements in technology including storage technology will make them more practicable. An important aspect of climate change policy is appropriate technology policy to accelerate R&D and research to resolve problems which require technologies to be proved at commercial scale and to assist in the early deployment of new technologies which often involve significant investment (GE Energy 2006). Collaboration between government⁴ and industry is essential to develop these technologies over the shortest possible time frames. In Australia, alternative energy sources are being developed by companies like Geodynamics⁵ and Solar Systems⁶ with projects supported by both Federal and State governments. In California's Silicon Valley, entrepreneurs are establishing companies into research and development of alternative technologies with companies like SunPower. New technologies include the use of mirrors to focus solar energy onto a smaller number of solar panels, called heliostat photovoltaic (HCPV) technology (to reduce costs), multi-junction solar cells that can absorb a broader wavelength of solar energy (to improve efficiency) and using heat generated from solar power to drive steam turbines to generate electricity in the conventional way (to improve distribution). See Solar Systems (2007b).

Globally, solar power is a \$38 billion industry and growing at 10% per year. Germany has become the unlikely leader in solar power by providing financial incentives to anyone that generates solar power to sell to the grid at \$54-47 per MWh, generating 10% of its electricity from renewable sources in 2005 and with 58% of the world's installed capacity in solar power. This is due to householders and farmers in rural areas generating power to be self-sufficient as well as sell to the grid, a model that could be adopted around the world.

In addition to new technology, there are structural factors that need to be addressed. Power generation is currently highly centralised with national grids used for distribution. New technologies are distributed generators and are unable to access network grids. Large scale renewable energy sources such as wind and wave power may be located too far from existing grids which are able to ameliorate differences in demand in various regions by distributing electricity where demand is greatest. Carbon capture and storage technologies require transportation of large quantities of carbon dioxide via new pipeline infrastructure at high cost. These issues are barriers to the deployment of new technologies and will inhibit the shift to low-carbon technology without appropriate incentives.

Transport

The transport sector is currently responsible for 14% of total GHG emissions and is the fastest growing source of global emissions because of the rapid growth of car and air transport. Cars are currently responsible for 45% of these emissions (Stern Review 2006). Higher fuel taxes and a carbon price on vehicle emissions will encourage the development of more fuel efficient vehicles including hybrid cars. Carbon pricing will also encourage more research into bio-fuels and other alternative transport fuels

⁴ The Australian Government Low Emissions Technology Demonstration Fund (LETDF) is a \$500 million program, which aims to foster competitive technology that will significantly reduce greenhouse gas emissions, see PMC (2007).

⁵ Geodynamics is currently the only public company in Australia that is fully focused on HFR geothermal energy, see Geodynamics (2007).

⁶ Solar Systems, an Australian public company is building a \$420 million large-scale solar power plant – the biggest and most efficient solar photovoltaic power station in the world in north-west Victoria. This is partly funded by a \$75 million grant to the project under the Federal Government's Low Emissions Technology Demonstration Fund (LETDF) and a \$50 million grant from the Victorian Government, see Solar Systems (2007).

such as hydrogen. In Brazil, for example, taxation and regulation has resulted in 13% of road fuels being supplied by bio-fuels. Alternative fuels such as the use of hydrogen in buses is already viable and will be in use at the Beijing Olympics in 2008. However some of these alternatives have high embedded costs such as the land clearing and energy requirements to extract ethanol from crops and to separate hydrogen from water.

The development of alternative technologies in road transport will be important in reducing emissions and the development of infrastructure that enhances public transport are key strategies to reduce emissions. As infrastructure life spans several decades, fresh approaches are essential for such investments if we are to avoid being locked into solutions that do not fully account for their environmental impacts.

Although aviation is responsible for a small share of GHG emissions, these are growing rapidly and there are currently few alternatives to this technology. Also the emissions have a far greater effect as they are released at high altitudes. It is estimated that if target emission reduction levels of 80 percent by 2050 are adopted, aviation could account for as much as 30 to 50 percent of total GHG emissions by 2050 because there are limited alternatives available (The Australia Institute, 2007). Technology initiatives are limited at present although there are schemes to offset emissions (Virgin Blue 2007).

Agriculture and Forestry

Curbing deforestation is a highly cost-effective way of reducing GHG emissions. Emissions from deforestation are estimated to represent more than 18% of total global emissions – a share greater than that produced by the global transport sector. (Stern Review 2006). This is due to GHG emissions released as a result of anaerobic decomposition of plant matter and the environmental impact of depleting carbon absorbing plant matter. Developing countries are the main source of these emissions and urgent action is needed to preserve remaining areas of natural forest. Carbon markets rather than technology solutions have a crucial role here by providing long term incentives through carbon credits to preserve these forests.

The agricultural sector is responsible for 14% of total GHG emissions, mainly from fertilisers, livestock, rice cultivation and the burning of forests. A high proportion of these emissions are from developing countries. Research into sustainable farming practices, such as agroforestry and permaculture can reduce GHG emissions and improve crop yields while research into livestock feeds, breeding and feeding practices can reduce methane emissions from livestock.

Other sectors

Emissions from industry are responsible for 14% of total GHG of which approximately 70% is from iron and steel, non-metallic minerals and the chemical and petrochemical sectors. Energy efficiency in these industries and the use of renewable sources of inputs are important in reducing GHG emissions⁷. (See Table 2)

Innovations in building technologies and urban planning can have a profound impact on emissions attributed to buildings (responsible for 8% of total GHG emissions) due to energy used for heating and lighting. Building standards that encourage energy efficiency, such as the rating systems developed by the Australian Greenhouse Office (Australian Greenhouse Office 2005), promote energy efficient design while re-use of waste materials can increase resource efficiency⁸. (See Table 3)

Consumer education and product labelling and information on energy efficiency such as the ENERGY STAR® labelling of appliances sold in Australia also promote efficient design in water and energy consumption and enable consumers to make effective choices for the home (AELA 2006).

⁷ See IPCC (2007), Chapter 7, for an analysis of emissions from various industry sectors and emission reduction technologies.

⁸ See IPCC (2007) Chapter 6 for a review of GHG mitigation options for residential and commercial buildings.

International perspectives

There is an urgent need for a global perspective of the problem and long term goals for climate change policy. The UN Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, UN Intergovernmental Panel on Climate Change (IPCC)⁹ and other dialogues provide a framework that supports co-operation and a foundation for collective action. On a global scale, creating a broadly similar carbon price and using international emissions trading schemes are crucial to accelerate action in developing countries which are especially vulnerable to the impacts of climate change (IPCC 2007, CANA 2007b and c). Linking and expanding regional emissions trading schemes requires international co-operation and new institutional arrangements.

International co-operation to accelerate technological innovation and diffusion such as the reduction of tariff barriers for low-carbon goods and services will provide further opportunities to accelerate the development of low emission technologies. It is also important to encourage technology transfer and investment in energy efficient technologies in developing countries rather than repeat the mistakes of the developed world. The Asia-Pacific Partnership on Clean Development and Climate (AP6 2007) brings together Australia, China, India, Japan, Republic of Korea and the United States of America to address the challenges of climate change, energy security and air pollution in a way that encourages economic development and reduces poverty. The partnership is an important initiative that engages, for the first time, the key greenhouse gas emitting countries in the Asia Pacific region on practical clean development and climate action. The AP6 is also unprecedented in the way business, government and researchers have agreed to work together and industry has been afforded an opportunity to contribute as equal partners in global climate change discussions.

Developing countries are taking significant actions to decouple their economies from growth in GHG emissions. China has a goal of reducing energy used for each unit of GDP by 20% from 2006-2010 and to promote the use of renewable energy. India has created an Integrated Energy Policy for the same period that include measures to expand access to cleaner energy for poor people and to increase energy efficiency.

The Role of Women Engineers – Making the Difference

Scientists and engineers are pivotal to meeting the challenges ahead. Engineers, in particular, have the requisite skills to address the technical and technological issues. Electrical engineers are vital to the power industry, mechanical engineers are needed to address transport issues, civil engineers are needed to design sustainable infrastructure and transportation systems, chemical engineers are required to develop solutions for chemical and petrochemical industries and mining engineers can solve the problems of the mining and minerals processing industries, to name a few examples. The demand for engineering skills is unprecedented, engineers are like no other professional group in their ability to address the challenges of climate change.

Tackling the problem of climate change requires the application of the whole of the available engineering skills base which is in critically short supply. However just as the burning of fossil fuels has led to environmental unsustainability, the science and technology sectors as a whole continues to use unsustainable work practices and cultures that persistently leads to the talents of women being wasted. In the UK, more than 70% of qualified women are not working in their specialist fields, leading to a skills and innovation gap (UK SET Women Resource 2007). There is a similar picture in Australia with approximately 60% of women engineers leaving the profession after 10 years (Engineers Australia 2002) and similar high proportions leaving the science and information technology fields (APESMA

⁹ The Intergovernmental Panel on Climate Change (IPCC) has been established by WMO and UNEP to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation. It is currently finalizing its Fourth Assessment Report "Climate Change 2007", also referred to as AR4. The reports by the three Working Groups provide a comprehensive and up-to-date assessment of the current state of knowledge on climate change, see IPCC (2007).

2007). The challenge is not only to attract women to engineering but to retain those already in the profession to solve the pressing problems ahead.

Globally, women are more vulnerable to the impacts of climate change due to their different social roles and status. Climate change will disproportionately affect the world's poor, approximately two thirds of whom are women. Women are also more vulnerable to death and injury from extreme weather events, are more vulnerable to communicable diseases, and have a greater reliance on subsistence agriculture (CANA 2007). Increasing costs for energy, transport, healthcare and nutrition are more likely to affect women.

Recent surveys indicate that women are very concerned about the impacts of climate change on future generations and on the environment. Higher proportions of female students enrol in fields like environmental engineering and are interested in careers that make a difference in society (Engineers Australia YoWIE 2007). Women have responded to the issue of climate change by making changes in their lifestyles in greater proportions than men, including strategies such as recycling and energy efficiency in the home. Women have a key role in tackling climate change as consumers and as change agents in their homes and with their children (WEN UK 2007b).

Women engineers have a unique perspective on climate change and a pivotal role in shaping long-term sustainable practices in industry and in their homes and in shaping future technologies to reduce GHG emissions. They understand the issue from a social and economic perspective as they have first hand experience in dealing with the impacts. They also understand the technological challenges and are able to work to making the changes that address climate change.

Conclusion

Climate change is one of the most important global threats to our future, it is imperative to take action as soon as possible to limit emissions and implement measures that will mitigate its impacts. Engineers, and in particular women engineers, have a vital role to play in developing and implementing long-term, sustainable low-carbon, resource and energy efficient technologies in a wide range of industries to meet this challenge. Women engineers are needed to make the difference.

Table 1: Key Characteristics of Different Emission Trading Schemes in Power Generation Currently Operating Source: OECD (2006)

	Eligible gases	Sources	Mandatory or Voluntary	Participants	Target: Indexed or Fixed	Time Scale	Non-compliance penalty?	Use of Offsets?	Banking	Unit
EU ETS (Phase I)	CO2	Combustion plants, oil refineries, coke ovens, I&S, cement, glass, lime, brick, ceramics, pulp and paper	M	Emitters	F	2--5-2007	Y, EUR 40 per tonne (+ shortfall to be made up in following year)	Y, CDM, excluding forestry	Allowed in some countries	1 tonne CO _{2e}
EU ETS (Phase II)	CO2 + opt in (eg N2O)	As above + possible opt in for some gases or sectors (eg industrial N2O in the Netherlands)	M	Emitters	F	2008-2012	Y, EUR 100 per tonne (+ shortfall to be made up)	Y, CDM, excluding forestry	Y	1 tonne CO _{2e}
Norway ETS	CO2	As for EU ETS Phase I	M for plants not under CO2 tax	Emitters	F	2005-2007	Y, same as EU Phase I	Y, same as EU Phase I	Y (2005-2007 only)	1 tonne CO _{2e}
NSW/ACT Scheme	6 GHG	Production and use of electricity	M	Electricity retailers, large electricity users	I	Initially 2003-2012, extended to 2020	Y, AU\$11.50/tonne if over emission not made up in following year	Y, some project types	Y (some offsets permitted)	1 tonne CO _{2e}
UK ETS (direct participants)	6 GHG	Various industrial sectors and energy use	V	Emitters and users	F	2002-2006	Y, GBP30 per tonne + make up credit in next year + non-payment of subsidy	N	Y	1 tonne CO _{2e}
Japan JETS	CO2	Food, breweries, pulp, chemicals	V	Emitters	F	FY 2006, FY 2007	Y, return of subsidy, "naming and shaming"	Y, CDM		1 tonne CO _{2e}
Chicago Climate Exchange	6GHG	Electricity generation, manufacturing industry	V	Emitters and offset providers	F	2003-2006, 2007-2010	No defined penalty	Y, certain countries or sectors	Y	1 tonne CO _{2e}

Table 2: Selected examples of industrial technology for reducing GHG (not comprehensive). Technologies in italics are under demonstration or development. Source (IPCC 2007).

Sector	Energy Efficiency	Fuel Switching	Power Recovery	Renewables	Feedstock Change	Product Change	Material Efficiency	Non-CO ₂ GHG	CO ₂ Sequestration
Sector Wide	Benchmarking; Energy management systems, Efficient motor systems, boilers, furnaces, lighting and HVAC, Process Integration	Coal to natural gas and oil	Cogeneration	Biomass, Biogas, Photovoltaics, Wind turbines, Hydropower	Recycled Inputs				<i>Oxy-fuel combustion, CO₂ separation from flue gas</i>
Iron & Steel	Smelt reduction, Near net shape casting, Scrap pre-heating, Dry Coke quenching	Natural gas, oil or plastic injection in blast furnace	Top-gas pressure recovery, By product gas combined cycle	Charcoal	Scrap	High strength steel	Recycling, high strength steel, reduction of process losses	n.a.	<i>Hydrogen reduction, Oxygen use in blast furnaces</i>
Non-Ferrous Metals	<i>Inert anodes</i> , Efficient cell designs				Scrap		Recycling, thinner film and coating	PFC/SF ₆ controls	
Chemicals	Membrane separations, Reactive distillation	Natural gas	Pre-coupled gas turbine, Pressure recovery turbine, Hydrogen recovery		Recycled plastics, bio-feedstock	Linear low density polyethylene, high-performance plastics	Recycling, thinner film and coating, reducing process losses	N ₂ O, PFCs, CFCs and HFCs control	<i>Application to ammonia, ethylene oxide processes</i>
Petroleum Refining	Membrane separation, refinery gas	Natural gas	Pressure recovery turbine, Hydrogen recovery	Biofuels	Bio-feedstock		Increased efficiency transport sector	Control technology for N ₂ O/CH ₄	From hydrogen production
Cement	Preheater kiln, Roller mill, <i>fluidized bed kiln</i>	Waste fuels, Biogas, Biomass	Drying with gas turbine, power recovery	Biomass fuels, Biogas	Slags, pozzolanes	Blended cements, <i>geo-polymers</i>		n.a.	<i>O₂ combustion in kiln</i>
Glass	Cullet preheating, Oxyfuel furnace	Natural gas	<i>Air bottoming cycle</i>	n.a.	Increased cullet use	High strength thin containers	Re-usable containers	n.a.	<i>O₂ combustion</i>
Pulp & Paper	Efficient pulping, Efficient drying, Shoe press, Condebelt drying	Biomass, landfill gas	<i>Black liquor gasification combined cycle</i>	Biomass fuels (bark, black liquor)	Recycling Non-wood fibres	Fibre orientation, thinner paper	Reduction cutting and process losses	n.a.	<i>O₂ combustion in lime kiln</i>
Food	Efficient drying, membranes	Biogas, natural gas	Anaerobic digestion, gasification	Biomass, Biogas, Solar drying			Reduce process loss, Water use		

Table 3: Companies and Products in Australia that have been certified as Greenhouse Friendly™ by the Australian Government Australian Greenhouse Office (current at June 2007):

Product	Description	Further Information
AGL Green Balance™	Consumer purchase of electricity from alternative energy sources	www.agl.com.au
BP Global Choice™	Business offset GHG emissions from vehicles and machinery	www.bp.com.au
Dulux Aquanamel® and EnviroO ₂ ™	Paints low in VOC (volatile organic compounds)	www.dulux.com.au/html/specifier/DuluxEnviroSolutions.pdf
Greenhouse Friendly™ services	GHG neutral printing and design services	www.mysitque.com.au
GreenEarth Gas Greenhouse Friendly	Consumer offset GHG emissions from gas consumption	www.originenergy.com.au
Greenhouse Friendly™ technology and project management services	GHG neutral technology consultancy and project delivery services	www.renewtek.com
Greenhouse Friendly™ television services	GHG neutral Channel Seven, Sunrise Breakfast Television Show	www.seven.com.au/sunrise
Earth Friendly Power	Consumer offset emissions by paying premium to support landfill gas flaring projects and other initiatives	www.synergy.com.au
Greenhouse Friendly™ airline services	Consumer offset emissions from air travel by purchasing appropriate offsets	www.virginblue.com.au

References:

1. **AP6 (Asia Pacific Partnership on Clean Development and Climate) 2007:** see <http://www.ap6.gov.au/>
2. **Australian Greenhouse Office, 2005:** Australian Government, Department of Environment and Water Resources, Australian Greenhouse Office, *Australia's Response to Climate Change*, 2005, available from <http://www.greenhouse.gov.au/>
3. **Australian Greenhouse Office, 2005b:** Australian Government, Department of Environment and Water Resources, Australian Greenhouse Office, *Climate Change, Risk and Vulnerability*, March 2005, available from <http://www.greenhouse.gov.au/>
4. **AELA (Australian Environmental Labelling Association) 2006:** *What is International Best Practice Eco-labelling*, see www.aela.org.au
5. **APESMA, 2007:** Association of Professional Engineers, Scientists and Managers Australia (APESMA), *Women in the Professions Survey Report (Preliminary) 2007*, http://www.apesma.asn.au/women/survey_report.asp
6. **Engineers Australia, 2007:** *Policy Statement on Climate Change and Energy*, February 2007, available from <http://www.engineersaustralia.org.au>
8. **EA WIENC (Engineers Australia, Women In Engineering National Committee), 2002:** Roberts, P. and M. Ayre, *Counting the Losses: A Careers Review of Engineering Women: an investigation of women's retention in the Australian Engineering Workforce*, see www.engineersaustralia.org.au/women/
9. **EA YoWIE (Engineers Australia, Year of Women In Engineering), 2007:** *Girl Talk*, Career Presentations by Women In Engineering to prospective female engineering students.
10. http://www.engineersaustralia.org.au/learned-groups/interest-groups/women-in-engineering/publications/publications_home.cfm
11. **CANA (Climate Action Network Australia) 2007:** *Impact (of Climate Change) on (United Nations) Millennium Development Goals*, see: <http://www.cana.net.au/socialimpacts/global/millennium-development-goals.html>
13. **CANA (Climate Action Network Australia) 2007b:** *Climate Change Impacts in Asia*, see: <http://www.cana.net.au/socialimpacts/global/asia.html>
14. **CANA (Climate Action Network Australia) 2007c:** *(Climate Change) Impacts on the Pacific and Small Island States*, see: <http://www.cana.net.au/socialimpacts/global/small-island-states.html>
16. **CCX (Chicago Climate Exchange) 2007:** *Carbon Financial Instrument (CFI) Contracts – Market Data*, June 2007, see www.chicagoclimatex.com/market/data/
17. **CEPS (Centre for European Policy Studies), 2002:** *Greenhouse Gas Emissions Trading In Europe: Conditions for Environmental Credibility and Economic Efficiency*, Brussels, 2002.
18. **CIA (Chemical Industries Association), 2006:** *Energy and Climate Change Policy*, March 2006, available from <http://www.cia.org.uk/>
19. **Commonwealth of Australia, 2002**, McMichael, A., R. Woodruff, P. Whetton, K. Hennessy, N. Nicholls, S. Hales, A. Woodward, T.Kjellstrom, *Human Health and Climate Change in Oceania: A Risk Assessment*, Canberra.
20. **Commonwealth of Australia, 2003:** Pittock, B. (ed.), *Climate Change: An Australian Guide to the Science and Potential Impacts*, Canberra.
21. **EPA Sweden, 2007 (Naturvardsverket):** Sweden's Climate Policy, see: www.internat.naturvardsverket.se
22. **EU 2003:** *Directive 2003/87/EC of the European Parliament and of the Council establishing a scheme for emission allowance trading within the Community and amending Council directive 96/61/EC*, see <http://europe.eu/eur-lex/pri/en/oj/dat/2003/>

23. **GE Energy 2006:** *R. Gleitz, The Case for Wind: GE Energy's Perspective*, GE Document Reference GER-4264, April 2006.
24. **Geodynamics 2007:** Geodynamics Business Plan, see: www.geodynamics.com.au
25. **IPCC (United Nations Intergovernmental Panel on Climate Change) 2007:** IPCC Fourth Assessment Report, Working Group III, May 2007, Draft, see: www.mnp.nl/ipcc/ or www.ipcc.ch
26. **NSW 2007:** NSW Government Greenhouse Gas Abatement Schemes, see http://www.greenhousegas.nsw.gov.au/overview/scheme_documents.asp
27. **OECD 2006:** Linking GHG Emission Trading Schemes and Markets, available from www.iea.org
28. **PMC 2006:** *Securing Australia's Energy Future*, Australian Government, Office of Prime Minister and Cabinet, Canberra, see: www.pmc.gov.au/publications/energy_future/index.htm
29. **PMC 2007:** *Building Our Future: Low Emissions Technology Development Fund*, Australian Government, Office of Prime Minister and Cabinet, Canberra, see www.pmc.gov.au/publications/energy_future/overview/15_future.htm
30. **Solar Systems 2007:** Solar Systems Ltd: 154MW Victorian Project, see www.solarsystems.com.au
31. **Solar Systems 2007b:** Solar Systems Heliostat Photovoltaic Technology, see http://www.solarsystems.com.au/HCPV_Technology.html
32. **Stern Review, 2006:** *The Economics of Climate Change*, 2006, HM Treasury (UK), available from <http://www.hm-treasury.gov.uk>
33. **The Australia Institute, 2007:** MacIntosh, A. and C. Downie, *A Flight Risk: Aviation and Climate Change in Australia*, Discussion Paper No. 94, May 2007.
34. **The Australian Climate Group, 2004:** *Climate Change, Solutions for Australia*, published by IAG Limited and WWF Australia, June 2004.
35. **UK SET Women Resource (U.K. Resource Centre for Women in Science Engineering and Technology), 2007:** *CEOs of SET Companies Commit to Change*, April 2007, available from www.setwomenresource.org.uk
36. **UK WEN 2007a:** Women's Environmental Network, *Getting in the Picture: A Survey of Women's Priorities for Action and Involvement in Tackling Climate Change*, May 2007, available from www.wen.org.uk
37. **UK WEN 2007b:** Women's Environmental Network, *Women's Manifesto on Climate Change*, May 2007, available from www.wen.org.uk
38. **Virgin Blue 2007:** *Fly Carbon Neutral*, Virgin Blue Offset Scheme for Air travel in Australia, March 2007, see: www.virginblue.com.au/carbonoffset/