

LOW-CARBON ECONOMY

BUSINESS OPPORTUNITIES FOR AUSTRALIA



Report by the
Low-Carbon Economy Task Force

October 2009

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EXECUTIVE SUMMARY



“If there’s not action before 2012, that’s too late.
What we do in the next two to three years will
determine our future. This is the defining moment.”

Rejendra Pachauri
Chairman of the United Nations
Intergovernmental Panel on Climate Change,
recipient of the 2007 Nobel Peace Prize

“Climate Change is the single most pressing environmental,
economic and social challenge this country faces.”

Confidential Treasury briefing to Wayne Swan
upon taking office, November 2007

This report has been developed by Global Access Partners (GAP) from the discussions of the Low-Carbon Economy Task Force – a group of scientists, public policy experts and businessmen brought together to explore commercial opportunities in Australia’s emerging low-carbon market. The task force investigated the impact of climate change and related policy development on the Australian business community and gave particular focus to improving economic efficiency and leveraging practical outcomes. The report reflects the group’s discussions and individual comments by Task Force members, but it should not be assumed that every participant would agree with every recommendation.

Business Opportunities in Australia’s Low-Carbon Economy

The reality of anthropogenic climate change is broadly acknowledged by the scientific community and the urgent need for remedial action is agreed in principle, if not always pursued in practice, across the developed world. The task of reducing carbon emissions while maintaining economic growth poses dilemmas for industry and government alike, but the environmental consequences of production can no longer be dismissed as ‘externalities’, when they threaten the survival of society.

Climate change presents a far more serious threat to Australia’s economy and way of life than is reflected in current political and economic policy. Immediate and radical change, rather than incremental reform, is demanded by the scale of the emergency. Such policies will inevitably incur short-term costs, but these are far outweighed by the long-term consequences of failing to tackle emissions.

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Business must position itself at the forefront of encouraging change, rather than resisting it. Australia's resilient economy and strong track record in solar development should see it emerge as a leader in low-carbon technology and enjoy the benefits of early adoption. Business and government must work 'hand in hand' to encourage Australia's shift to a low-carbon economy and assist other countries to identify opportunities for green growth. A government commitment to radical cuts in carbon emissions by perhaps up to 25% would spur domestic innovation and spearhead desperately needed international measures to ameliorate climate change.

Climate change is as much an economic as an environmental issue and should be tackled with arithmetic, rather than adjectives. The concept of economic rationality must evolve to encompass the severe costs which 'business as usual' will impose on future generations, but it is clear that 'going green' already makes clear business sense.

A transition to a low-carbon economy will transform agriculture, primary extraction, manufacturing, services, supply chains and consumer behaviour. Businesses which embrace change as a new opportunity will prosper, not least because energy efficiency will garner significant cost savings. A 'green industrial revolution', prompted by internationally agreed targets, a retargeted regulatory framework and environmentally conscious consumer demand will reinvigorate the economy just as globalisation, the internet and deregulation have done before.

"Climate smart" programs, energy audits and green marketing are beginning to reap dividends, but voluntary schemes will only be effective if linked to statutory targets in years to come. Although progress of the Carbon Pollution Reduction Scheme has stalled in the Senate, it seems inevitable that some form of carbon tax, levy or 'cap and trade' system will be introduced to encourage industry to account for the cost of their greenhouse emissions. This price signal will ensure energy and waste efficiency becomes integral to every stage of production and consumption and reward proactive companies seeking, developing or marketing low carbon solutions in energy, transport and manufacturing. The capture and storage of carbon produced by coal and gas fired generation and bio-sequestration, through the protection of native forests, reforestation of denuded land, better grassland management and bio-char, must also play a comprehensive and cost effective role.

Businesses must understand the global issues, minimise their exposure to risk and maximise their opportunities to reduce costs and exploit new markets and technology. New standards for buildings, appliances and vehicles will stimulate demand for replacement goods while carbon taxes should be publically invested in low-carbon infrastructure and research.

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Through broad political resolve, enlightened business initiative and informed public action, Australia should pursue growth through the transition and reap the benefits of leadership in innovation, science and technology.

New production techniques and alternative energy technology will find lucrative markets beyond Australia, particularly in energy-hungry South East Asia, while a pro-active Government stance in international negotiations will ensure that Australia's efforts are leveraged worldwide. The adoption of rigorous energy efficiency standards in the developed world will force manufacturers in China and elsewhere to build to them and sell them worldwide. Australian innovation in clean coal technology is vital, given Australia's reliance on coal fired generation and the colossal emissions from Indian and Chinese power plants in their drive for much needed growth.

Global private equity and venture capital investment in clean energy technology, companies and projects soared from \$1.3 billion US in 2003 to over \$32 billion US in 2008. It is not for the Government to pick 'winners' amongst so many new ideas, rather to create a transparent and equitable regulatory regime to allow businesses to invest with certainty and compete on merit.

While there are lessons to be learned from other nations, particularly Japan's exemplary energy efficiency, French nuclear generation and the patchy record of renewable sources in Europe, no economy has ever been 'decarbonised' and so the adoption of a broad spread of measures, rather than any single 'silver bullet', is the prudent course. Only the combined effect of a comprehensive swathe of measures and the involvement of every company and household in the country can hope to stem the tide of climate change.

The time to act is now. A report commissioned for the Climate Institute in the run-up to the Copenhagen talks highlighted Australia's poor performance in the G20 group of major economies. Australia is ranked 15th, the lowest of any industrialised G20 nation and ahead of only South Africa, India, Saudi Arabia and Indonesia, in a 'Low Carbon Competiveness Index' due to its carbon intensive exports of coal, high car use and coal fired power generation. Although it ranks 7th in terms of improving its carbon performance, it still languishes 16th in a 'Carbon Gap Index' which measures the rate of carbon productivity growth required to meet its international emissions obligations. If the situation is not treated as a genuine emergency, Australia risks missing out on a host of opportunities for investment, jobs and profits in clean energy emerging industries.

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The G20 Carbon Competitiveness Briefing Paper concludes that Australia needs to “more than double its rate of carbon productivity improvement”, which will require “significant turnarounds in performance and strong near-term policies and measures”. It also warns that the longer it takes “to achieve these turnarounds, the more costly the eventual transition will be.”

The Scientific Reality

Australia’s carbon output increases by 2% per year and it remains one of the worst per capita offenders due to the dominance of coal and a long history of land clearing. The country has warmed by 0.5 degrees since 1950 and, given its predisposition to drought and sensitive ecology, is particularly vulnerable to climate change. Furthermore, measures taken to combat emissions may also have severe impacts upon its vital tourism, agricultural, coal mining and gas production sectors.

“Climate Change in Australia”, a 2007 report from CSIRO, warned that temperatures will increase by 1°C by 2030, with the position by 2070 dependent on measures taken now. “If emissions are low, we anticipate warming of between 1°C and 2.5°C around 2070, with a best estimate of 1.8°C”, one of the report’s authors, Dr Penny Whetton confirmed. “Under a high-emission scenario, the best estimate is 3.4°C, with a range of 2.2°C to 5°C.”

A statement by the Hon. Greg Combet on ‘The Scientific Imperative for Action on Climate Change’ on 12 August 2009 put the issues into stark relief in support of the Government’s CPRS. He noted the scientific consensus regarding the reality of anthropogenic climate change and the urgency of carbon reduction measures to address it. Spelling out the threats posed by rises in sea level, exacerbated heat and drought conditions, water shortages, ocean acidification, degradation of World Heritage Sites, human health impacts and economic losses, Minister Combet urged the adoption of a carbon trading scheme before global ‘tipping points’ in carbon concentration were reached.

The Policy Gap

Although the Rudd Government finally ratified the 1997 Kyoto agreement, its own Carbon Pollution Reduction Scheme has still to pass into law due to objections in the Senate. While a meeting of 2,500 climate scientists in Denmark in March 2009 called for drastic action to cut carbon emissions to avert “irreversible shifts in climate” and demands for radical action are

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increasing before the Copenhagen round of talks, Australia's current performance has been judged as 'poor', compared to other leading developed countries according to a report commissioned by the Worldwide Fund for Nature and financial services firm Allianz. Greg Bourne, CEO of WWF-Australia, said, "in terms of overall Climate Change Scorecard performance, Australia is located in the 'red zone' along with Russia, Canada and the US. Australia's overall poor result indicates that the Government has some tough decisions ahead of it, not least of all in relation to the design of an emissions trading scheme, if it wants to raise Australia's overall climate change performance."

Implications for Business

Given the financial turmoil of the world economy over the past eighteen months, the need for stability and predictability in domestic and international environmental policy is more pressing than ever. Australian businesses can only invest in the long term low-carbon solutions required, if they can rely on firm intergovernmental agreements being signed and adhered to abroad and a consistency of purpose at home. The Government must focus on intelligent regulation, clear price incentives and innovation friendly policies if it is to unlock the potential of the Australian business community to tackle carbon emissions and the resulting threat of climate change.

Key Recommendations of the Low-Carbon Economy Task Force

- **Urgency of reform:** Incremental change to conventional business practices is no longer acceptable and a transformative change is necessary at both government and business levels. Australia needs to lead a "Clean Industrial Revolution" and has much to lose both environmentally and economically, if rapid action is not taken. Early adoption of less damaging methods of energy generation and low carbon methods of production and distribution will create a wealth of commercial opportunities and increase Australia's competitive advantage.
- **Business leadership:** Business must play a central role in the fight against climate change; indeed, the need for public leadership from major corporate players has never been greater. The decoupling of economic growth and greenhouse gas emissions is vital if mitigation measures are to prove economically and politically viable. Companies should plan today to adapt and grow in the low-carbon environment of tomorrow. Even the smallest firm can task an employee to monitor environmental performance and drive practical cost effective improvements.

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- **Realistic and sustainable pricing mechanisms and incentives:** Business adaption will suffer in the absence of a clear pricing mechanism and incentives for regulating carbon emissions. The Government should partner business by pursuing credible, predictable, transparent and flexible market-based solutions and give clear price signals to encourage environmentally friendly economic growth. It must also energetically pursue international agreements on greenhouse gas reduction if Australia's efforts are to be worthwhile. A greater emphasis on biological sequestration, forest conservation and improvements in agricultural practices may offer a range of effective solutions at comparatively low cost.
- **Risk assessment & management:** Prudent firms will address the risks they face from tighter regulations, adverse weather events, higher raw material and energy bills, loss of demand for high carbon products and blows to their public reputation from adverse environmental publicity. Given Australia's sensitivity to the early impacts of climate change, its businesses are ideally placed to develop new techniques and technology and show leadership on the world stage.
- **Commitment to change:** Carbon management should become a fundamental part of the business planning processes and carbon accounting is set to take its place alongside its financial counterpart. A public and sincere commitment to change is the first and most important step, followed by systematic calculation of a firm's carbon footprint to identify 'hot spots' for immediate energy savings and the most cost effective avenues for long-term emission reform.
- **Short and medium term targets:** In the short term, businesses can profit from reducing waste and exploiting 'green' consumer markets. Carbon efficient logistics are vital as emissions in a company's value chain may increase costs or reduce sales, even if the company itself is not directly subject to regulation. In the medium term, international emission targets, domestic carbon pricing, stringent pollution regulations and investor, consumer and stakeholder pressure will inevitably force most Australian firms towards carbon reform. Businesses which act 'ahead of the curve' to reduce risk, seize opportunities and mitigate increasing compliance costs will entrench a valuable competitive advantage over less pro-active rivals.
- **Cultural change within businesses:** Carbon reduction measures must be implemented on a consistent and comprehensive basis throughout the organisation and along the supply chain. Care must be taken to educate and re-skill the workforce to assure their co-operation and to engage with their ideas. Teamwork is vital, and only a combination of leadership from CEOs, focus by management and commitment from employees will succeed.

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- **Environmental self-regulation:** Environmental performance must be at the core of every modern company's values, objectives, performance and structure. Environmental goals cannot be an afterthought to decisions made on traditional criteria. Previous experience in tackling pollution proves that socially desirable reform can benefit the business community and achieve greater results at lower cost than conventional wisdom suggested. Firms which embrace Australia's bright future with optimism and action today will only stand to gain from the transition to a low-carbon economy of tomorrow.

List of Recommended Projects

Businesses must actively investigate and pursue investment opportunities in low-carbon technologies and programmes. The Low-Carbon Economy Task Force recommends the following avenues as both fruitful business opportunities and strategies which could deliver significant carbon reductions:

► **Create and manage a meaningful low-carbon certification for SMEs**

The creation of a single government agency, similar to Standards Australia, to assess the carbon footprint of any willing business would be invaluable. An independent, reliable and officially endorsed assessment would allow proactive businesses to plan efficiently for the onset of carbon pricing. The data gathered could be used in a global database of industry emission profiles, driving best practice solutions around the world.

► **Support the urgent implementation of Biological Sequestration**

The potential for biological sequestration to fix large quantities of legacy CO₂ from the atmosphere as terrestrial soil carbon has been largely ignored by the present Government. The government should fund studies and trials of Bio-Carbon Capture and Storage and lead its rapid implementation alongside its stated commitment to Geological Carbon Capture and Storage.

► **Adopt CleanTech Mapping Methodology as a strategic model to create and coordinate industry clusters for joint commercial opportunities**

The Australian CleanTech Industry Portal provides a model for the creation of similar internet-based resources to enable companies to co-operate on mutually beneficial and environmentally friendly projects, with support from relevant departments of industry development at both federal and state levels.

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► **One-to-one engagement with CEOs of major companies**

Many business leaders remain reluctant to drive carbon mitigation measures, unconvinced of the need for action or apprehensive at its cost and possible impact on their firms. The engagement of such decision makers by government figures and industry leaders could be decisive in kick-starting engagement and help develop programs specifically tailored to address these companies' concerns and deliver workable solutions.

► **Target energy efficiency in existing, as well as new buildings**

The mandatory disclosure of the energy efficiency rating of residential and commercial properties when sold or leased will commence in May 2011. This is a direct result of green legislation and will create a \$500 million dollar per annum industry overnight.

► **Adopt a 'Green Business' model**

Traditional business plans must evolve to take account of new green imperatives. The design and manufacture of products must embody a 'life cycle' approach when calculating their greenhouse gas impact and their use by the consumer and eventual disposal or recycling must be taken into account. Government incentives could have a major role to play. The creation of model green businesses should be encouraged and could drive the wider adoption of, for example, micro-solar power generation for small businesses.

► **Offer personal incentives for people to reduce carbon emissions**

Reducing the demand for power is more efficient than producing that power with fewer emissions. Personal incentives to encourage conservation and rationalisation of resources could prove cheaper than massively expensive engineering solutions. Such alternative approaches could encompass personal carbon trading.

PART ONE - Introduction

1.1 The Low-Carbon Economy Task Force

The Low-Carbon Economy Task Force was established by Sydney-based policy network Global Access Partners (GAP) in 2009 to develop thought leadership and explore commercial opportunities in Australia's emerging low-carbon market. The group included scientists, public policy experts and concerned businessmen and was chaired by Dr John Hewson AM. The task force was borne of the realisation that the current carbon debate has failed to focus on the positive business opportunities offered by the prospect of a low-carbon economy.

The task force investigated the impact of climate change and related policy development on the Australian business community. Drawing on its members' personal and professional interest in the debate, the group gave particular focus to improving economic efficiency and leveraging practical outcomes.

This report represents the output of the task force meetings and supporting research. The report is reflective of the discussions and contributions of task force members, but it should not be assumed that every participant would agree with every recommendation. For much of the background material, the report draws upon existing reviews and research into business opportunities in a low-carbon economy.

The report is structured as follows:

Part Two gives an overview of the global picture on climate change and Australia's greenhouse gas emissions, examines the potential implications of future climate change for Australia and discusses current carbon policies and public opinion.

Part Three examines the risks and rewards inherent in any concerted move towards a low-carbon economy.

Part Four outlines commercial opportunities for Australian industries in the primary, secondary and tertiary sectors.

Part Five reviews alternative approaches to tackling climate change.

1.2 Global Access Partners (GAP)

GAP is a proactive and influential non-profit network which initiates high-level discussions at the cutting edge of the most pressing commercial and social issues of today. Through conferences, missions, advisory boards and online think-tank Open Forum, it promotes Australia's capacity to find novel solutions to the challenges facing the global community and translates these innovative solutions into business opportunities.

In 2007, after a decade of brokering between business, government, academia and the community in pursuit of practical outcomes, GAP began its 'Second Track' Process initiative. The 'Second Track' is a new method of government consultation, through which previously ad-hoc mechanisms for stakeholder engagement in policy development and decision making become an accepted method of 'fast-tracking' solutions to key issues. The process brings together experts from relevant sectors, including government, business, non-government organisations and consumers. Working collaboratively, with a positive approach, these groups identify problems, initiate discussions, prepare papers, develop practical solutions and oversee their implementation. The success of GAP initiatives demonstrates that such innovative avenues of stakeholder interaction can be further refined for the public good, without compromising the integrity of public procedure.

From their inception in 2003, GAP's initiatives in the field of ecological sustainability have ranged from assessing the resilience of Australia's urban infrastructure in the face of increasing climate variability through water and energy resource management and the role of ICT in environmental security to commercial opportunities in Australia's emerging carbon market.

In 2008, in association with the Allen Consulting Group, GAP ran a series of forums for key officials and regulators from the Commonwealth, New South Wales and Victorian governments and representatives from the water industry to address the challenges facing the urban water sector. The Forum's final report *"Urban Water: A vision for national road map for national progress"* maps out a pathway for achieving this vision, drawing on formal analysis and input from industry and government practitioners. The report was launched on 4 August 2009 at Parliament House in Canberra by the Hon. Dr Mike Kelly AM, MP, Parliamentary Secretary for Water.

GAP has also supported online public discussion of topics such as Sustainability Insights, Environmental Capitalism and the Carbon Economy through Open Forum.

PART TWO - Climate Change Today - and Tomorrow

2.1 The Global Picture

Scientific interest in an atmospheric 'greenhouse effect' dates back to Fourier's original hypothesis in 1827. Tyndal identified water vapour and carbon dioxide (CO₂) as heat trapping gases in 1860, and in 1896 Arrhenius calculated the extent to which the earth is warmed by its atmosphere and predicted future warming from the release of CO₂. Professor Wally Broecker coined the phrase 'global warming' in 1975 in publishing "Climate Change: Are we on the Brink of a Pronounced Global Warming?", but only in the last 15 years have concerns of climate change come to dominate the headlines and political and economic debate.

Humanity has pumped more than 1,800 billion tonnes of CO₂ into the atmosphere since the industrial revolution, and every second 1,000 tonnes are now released into the air. The current level of atmospheric CO₂, 383 parts per million, is the highest it has been for 650,000 years. Its concentration has increased 38% from pre-industrial levels due to the combustion of fossil fuels and global forest destruction. The United Nations-sponsored Intergovernmental Panel on Climate Change (IPCC) estimated that CO₂ will pass 1,000 parts per million by 2100 without emission curbs. The earth's average temperature is at least 0.8 degrees higher than in 1750 and is now increasing at 0.2 degrees a decade. If the emissions of OECD countries remain unmoderated and large, fast-developing nations such as China and India continue their expansion of coal fired power stations, atmospheric CO₂ will leap by a third by 2020 instead reducing by the 5% approved in the Kyoto Protocol.

The IPCC report warned climate change would precipitate more droughts, floods and storms, higher hurricane intensity, rising sea levels, declining crop yields, degraded fisheries, damaged reefs and widespread extinctions. Such environmental disasters would inevitably have major social and economic consequences, damaging infrastructure, destabilising financial and energy markets and boosting the cost of insurance.

If climate change pushes failing states towards collapse or sparks 'resource wars', Australia's own national security will be compromised. Sir Nicholas Stern, the renowned British economist and academic, likened its impact to that of World Wars or the Great Depression. The need to limit temperature increases to less than 2 degrees has been widely discussed, with increasing calls to adopt targets of 1 degree or below. The forthcoming Copenhagen conference in December 2009 will discuss the next stage of international action.

PART TWO - Climate Change Today - and Tomorrow

The recent global downturn has led some to question the cost of carbon reduction emissions, but the fall in production has led to reductions in carbon emissions while stimulus spending has been widely targeted at environmentally friendly measures. A 2009 UNEP report notes that 79% of South Korea's stimulus spending has a 'green component', as does 34% of China's and 20% of Australia's. This compares to 18% in France, 17% in Great Britain, 13% in Germany and 12% in the United States. This equates to over \$1,230 per head in South Korea and \$420 in Australia.

The record of measures undertaken so far is mixed. A study led by Dr Michael Raupach of CSIRO Marine and Atmospheric Research reported a near tripling of the growth of global CO₂ emissions, from 1.1% to 3.1%, in the last 15 years. Almost 8 billion tonnes of carbon was emitted into the atmosphere in 2005 compared with 6 billion tonnes a decade before. Chris Field of the Carnegie Institution believes global emissions have grown faster than the worst scenarios envisioned by the IPCC. In a study published in the journal of the National Academy of Sciences he wrote, "We are not seeing evidence of progress in managing those emissions in either the developed or developing countries. In many parts of the world we are going backwards".

A paper published in the same journal in February 2009 asserts that climate change will be "largely irreversible for 1,000 years after emissions stop" and that about 40% of the CO₂ produced by humans this century will remain in the atmosphere until at least the year 3000. Given the oceans' absorption of atmospheric heat, it argues that average temperatures will "remain approximately constant ... until the end of the millennium" even if there were no further emissions. Another paper, by Myles Allen, concludes that humanity can produce only 63 to 75 years of current emissions (1,830bn tonnes of CO₂) before 2500 if warming of more than 2 degrees is to be avoided.

CO₂-e now stands at 430 parts per million and is rising at 2 parts per million a year. If the aim is to stabilise concentrations at between 450 and 500 parts per million, global emissions of greenhouse gases must peak in the next 15 years and fall by at least 50%, relative to 1990 levels, by 2050. This will mean that per capita global emissions are reduced to 2 tonnes. This can only be achieved if global deforestation, responsible for around 17% of global emissions and still rife in Africa, Brazil and Indonesia, comes to an end and electricity generation, the largest single emitter, and transport become largely carbon neutral as well.

PART TWO - Climate Change Today - and Tomorrow



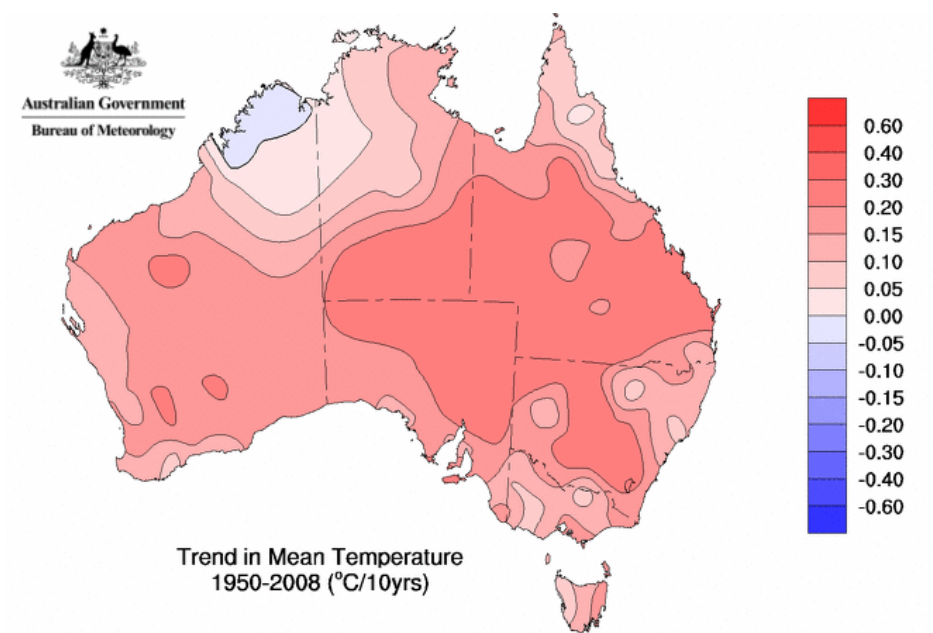
**Gippsland, Sunday night,
February 20th, 1898**
John Longstaff, 1898
National Gallery of Victoria

2.2 The Lucky Country

Australia, 'the lucky country', is the world's driest inhabited continent and long accustomed to extremes of heat, drought and natural disaster. In 1851 a calamitous bushfire incinerated 25% of Victoria, with the "Argus" recording the temperature on 6 February as 117° F and the smoke turning day into night over northern Tasmania. The "Federation drought" wiped out half the stock in Eastern Australia and a series of major droughts afflicted the region again in the late 1930s and early 1940s.

The 0.5 degree increase in Australia's average temperature in the last half century has exacerbated the situation. Heavy rainfall events have increased with more intense cyclones and severe east coast lows while average rainfall has declined in southern and eastern states. Sea levels have increased by 2 cm a decade for the past fifty years.

Figure 1. Trend in Mean Temperature 1950-2008



Source: Australian Bureau of Meteorology, January 2009

The impact of such incremental changes can be hard for individuals to comprehend, however, the appalling Victorian bushfires of February 2009 which killed an unprecedented 173 people and destroyed 1,800 hundred homes convinced many that Australia's climate is growing more extreme. The fires followed a week in which 200 people died of heat related causes.

PART TWO - Climate Change Today - and Tomorrow



**Victorian bushfires
from space**

A Royal Commission, due to report later this year, is expected to draw a link between the heat wave and long-term climate change, while a 2006 report has already identified South Eastern Australia as one of the 3 most fire-prone areas in the world.

The Governor of Victoria, Professor David de Kretser, called climate change “the greatest problem confronting mankind at this time” and had no doubt “that it has reached the level of a state of emergency” at the launch of ‘Climate Code Red’ on 17 July 2008.

The fires came in the context of a severe and prolonged drought which saw rainfall below half its historical average in many regions. Among the worst affected areas has been the vital Murray-Darling basin. Historically the Murray, Darling and Murrumbidgee rivers flow from the western slopes of the Great Dividing Range to water lush agricultural valleys and a remnant patchwork of native grasslands, marshes and eucalyptus forests. However, Australia’s ‘fruit and bread basket’, larger than France and Germany, is running out of water after 12 years of shortfall, and cotton and rice farming in the desiccated region are in terminal decline.

A study by the CSIRO found that southern Australia has warmed 1.6° F and enjoyed 15% less precipitation since 1950. A warming Indian Ocean has changed sea and air circulation patterns to stream drier air over the state. Scientists working on the \$7 million South Eastern Australian Climate Initiative, a three-year collaboration between the Bureau of Meteorology and CSIRO, claim 80% of the decline in precipitation can be attributed to the intensification of the subtropical ridge, due to greenhouse gases, aerosols and ozone depletion, which pushes rain storms south over the ocean.

60,000 farmers depend on the Murray-Darling, but reservoirs are less than half full and the river can fail to flow into the southern ocean as competing agricultural, industrial and domestic interests haggle over the dwindling supply. Further degradation of the Murray-Darling basin would jeopardise a broad swathe of Australia’s \$30 billion agricultural production. More than 20% of the fruit trees in the famous Goulburn Valley have been grubbed up in recent years, and by 2003 the drought had already cost Australia \$13 billion (1.6% of GDP) and up to 70,000 jobs. Irrigation schemes, which waste as much water through evaporation and leakage as they deliver to the land, are now being overhauled in a \$10 billion National Water Initiative, while 4 of the 6 States have agreed to let the Commonwealth lead water management for the first time.

CASE STUDY

Safe Climate Australia was formed by a group of concerned scientists and community and business leaders to advocate emergency action to tackle climate change. It aims to build on a range of innovative international projects and promotes energy efficiency, renewable generation, a modern national smart grid and the electrification of transport as key actions to address global warming, energy security and peak oil.

PART TWO - Climate Change Today - and Tomorrow



**Healthy coral community
and degraded coral
formation**

In contrast, monsoon flooding and mosquito-borne malaria and hemorrhagic dengue fever are increasingly common in Australia's far north, while warming tropical waters in the Coral Sea and the Gulf of Carpentaria trigger more powerful cyclones. Darwin currently suffers 20 to 30 days of high humidity and plus 30 temperatures per year, but government scientists project that by 2070, if climate change is not abated, Darwin will swelter in such conditions for up to 300. As Victoria burned, flooding saw isolated communities on the Cape York Peninsula cut off for weeks, with supplies air dropped throughout February 2009, while rising ocean temperatures are bleaching expanses of coral on the Great Barrier Reef, threatening its \$1.5 billion dollar tourist industry.

Tim Flannery, Australia's most prominent climate change campaigner, has called Australia "the harbinger of change" and argues that "the cost to Australia from climate change is going to be greater than for any developed country. We are already starting to see it. It's tearing apart the life-support system that gives us this world."

Data from Australia's 850 weather stations are expected to show the nation has just experienced its warmest winter since records began. Melbourne's rainfall for the first eight months of 2009 is the lowest on record, 0.2mm under the previous low of 1997, while Queensland recorded its driest July and August and New South Wales' rainfall remained under the historical mean.

2.3 Australia's Greenhouse Gas Emissions

The Federal Government reported Australia's net emissions to be 576 million tonnes of CO₂-e in 2006, about 1.43% of the global total. The energy sector contributed half of this amount with 287.4 million tonnes, transport and agriculture 15%, land use changes 7%, industry 5% and waste 3%. Although Australia was responsible for just 1.1% of all CO₂ emissions between 1850 and 2002, Australians rank 8th worst in the world on a per capita basis, with 28.1 tonnes of carbon per person, the highest figure in the developed world and more than five times the per head figure for China.

The energy sector is the main source of CO₂, while agriculture accounts for over half the methane released, highlighting the need to tackle those two sectors in any mitigation plan. Overall, CO₂ represented 74% of Australian emissions (427.8 million tonnes), methane 20.5% (118 million tonnes), and nitrous oxide 4% (24.2 million tonnes). The amount produced by land clearing fell from 96.5 to 40 million tonnes from 1990 to 2006 due to limited measures to protect native vegetation.

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Australia is the world's largest exporter of coal and uses it to generate 77% of its electricity. Only Poland, China and South Africa also rely on coal for more than 75% of their needs. The CO₂ emissions from the proposed increase in coal export capacity of several major Australian ports will dwarf the proposed reductions in domestic emissions from the Carbon Pollution Reduction Scheme. Australia imposes safeguards on the export of uranium, but does not impose requirements for the capture and sequestration of carbon from its exported coal or liquefied natural gas. Australia has approximately 40% of the world's uranium reserves and is the second largest producer of uranium behind Canada, but has no commercial carbon free nuclear power industry.

CSIRO analysis shows that Australia's emissions of CO₂ have risen at almost twice the world average over the past 25 years, and the country uses 25 to 30% more fuel per unit of energy produced than the US, Europe and Japan. The amount of coal, petroleum or gas burned to create a dollar of wealth is double that of Japan and Europe and 25% higher than the average overall.

2.4 The potential Impact of future Climate Change on Australia

The IPCC report warned of irreversible losses of biodiversity in the Great Barrier Reef and Queensland's wet tropics by 2020 and intensifying droughts in southern and eastern Australia by 2030, decimating agriculture and forestry. In the longer term, it warned that Australia's ongoing coastal developments would be threatened by storms and coastal flooding by 2050.

The Department of Climate Change issued a report by Professor Will Steffen of the Australian National University in July 2009, which cautioned that climate change was occurring more quickly than previously predicted and with more deleterious effects. "Climate Change – Potential Impacts and Costs" warned that "...ecologically rich sites, such as the Great Barrier Reef, Queensland Wet Tropics, Kakadu Wetlands, Australian Alpine areas, south-western Australia and sub-Antarctic islands are all at risk, with significant loss of biodiversity projected to occur by 2020...Very conservatively, 90 Australian animal species have so far been identified at risk from climate change, including mammals, insects, birds, reptiles, fish and amphibians from all parts of Australia."

The CSIRO predict dire environmental degradation from increases of between 2 and 3 degrees, including a 97% bleaching of the Great Barrier Reef, the loss of up to 40% of the principal habitat for Victoria and montane tropical vertebrates and, for example, 98% reduction in Bowerbird habitat in Northern Australia. 80% of freshwater wetlands in Kakadu would be lost to a 30 cm sea level rise.

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As the most ancient and eroded of the continents, Australia has the flattest topography, limiting the refuge heat intolerant plants and animals can find by retreating up the mountainsides. "If you are at the top of the mountain, it will only take a couple of degrees to push you off the top," notes Stephen Williams, director of the Centre for Tropical Biodiversity and Climate Change in Townsville, who predicts up to 50% animal extinction in the region by the end of the 21st century. The rare white lemuroid ringtail possum is one of the most critically endangered species. Described as 'our panda' by Tim Flannery, it lives in limited ranges of moist forest in northeast Queensland and has declined markedly in recent years. A 1 degree rise in temperature would reduce Australia's wet tropical mountain rainforests by 50%.

Australia is already arid or semi arid for the most part with increasing pressure on urban water supplies. Australia is more heavily dependent on agriculture than most developed countries, and recent history has shown its vulnerability to damaging wildfires and the fragility of its eco system faced with invasion by alien species. The export livestock industry generates \$17 billion a year, but, due to drought and soil depletion, already teeters at the brink of environmental sustainability, and a 2 degree increase in average temperatures would cut the carrying capacity of pasture by 40%.

Australia's \$32 billion tourism market employs or indirectly supports 16% of the workforce and generates 12% of export revenue. Loss of natural attractions, news of disasters and possible future restrictions in air travel would imperil the industry, while a predicted 8% decrease in precipitation would reduce snow cover in the Australian Alps by two thirds and its \$550 million skiing industry by half. Ocean fisheries, already threatened by over exploitation, may decline due to rising sea temperatures and acidification, and the \$260 million western rock lobster harvest would be adversely affected by possible changes in the Leeuwin current.



Sydney's Five Dock Bay during a dust storm, 23 September 2009

The CSIRO believes a temperature rise of between 2 and 3 degrees will see an increase of wind speeds in tropical cyclones of 5 – 10% and rainfall increases of 20-30%. The forest fire danger index in NSW and WA would increase by a tenth and in south, central and north east Australia by a higher rate still. Payouts after extreme weather events would increase the cost of insurance, leaving it beyond the reach of many citizens and increasing their destitution when struck by calamity. Since 1967, 19 out the largest 20 property insurance losses in Australia have been caused by extreme weather, with the Sydney hailstorm of 1999 costing \$2 billion alone.

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Even if temperature rises were limited to a best case scenario of between 1 and 2 degrees, the CSIRO predicts 12 to 25% reductions in water flows in the Murray River and Darling River basin and a 7 – 35% reduction in Melbourne's already inadequate water supply. Water shortages would also affect electricity generation, as occurred in Queensland in 2002, as large amounts are required for turbines and cooling. Increased air conditioning in hot weather increases electricity demand, and power cuts would become a possibility.

Australia's long coastline holds most of its population and could be imperilled by rising sea levels, with Cairns, for instance, threatened by a 22% rise in 100 year storm surge height and a doubling of the vulnerable area. In the longer term, increases of a metre would threaten Manly, Botany, Narrabeen, Port Botany, and Rockdale around Sydney and Drummoyne and Concord on the Parramatta River. In Melbourne, Port Phillip communities such as St. Kilda, Altona, Point Cook, Port Melbourne, Albert Park, Carrum, Patterson Lakes, Safety Beach, Rye and Tooradin would be threatened as would many new developments in Brisbane and on the Gold Coast.

2.5 Current Australian Policy

Under the Kyoto Protocol, ratified by the Labor Government a decade after its original signing in 1997, Australia pledged to limit its emissions to 108% of 1990 levels by 2012. The country is on track to achieve this, due to significant reductions in land clearing in New South Wales, however, overall emissions may still rise to 122% of 1990 levels in 2020 due to increases from energy, transport and agriculture. The Carbon Pollution Reduction Scheme, designed to create a market in pollution permits and encourage low-carbon solutions through the price mechanism, has been rejected by the Senate. The Howard Government introduced a Mandatory Renewable Energy Target in 2001 and the Rudd Government's 20% Renewable Energy Target, Clean Energy Initiative and energy efficiency measures have proved less controversial.

National, state and territory bodies have supported a National Biodiversity and Climate Change Action Plan, while the Department of Climate Change runs the National Climate Change Adaptation Programme. The National Climate Change Adaptation Research Facility at Griffith University offers "national leadership in the development and implementation of adaptation research".

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Launched in January 2006 at the inaugural Ministerial meeting in Sydney, **The Asia-Pacific Partnership on Clean Development and Climate** is an international agreement between Australia, Canada, India, Japan, China, South Korea, and the United States to develop and transfer technology which reduces greenhouse emissions. Ministers agreed a Charter, Communique and Work Plan that "outlines a ground-breaking new model of private-public taskforces to address climate change, energy security and air pollution."

The Government has signalled its intention to reduce greenhouse gas emissions to between 4 – 14% below 1990 levels by 2020. Alternatively, it will seek cuts of a quarter, if an international protocol to stabilise concentrations at 450 parts per million is signed. This equates to a per capita reduction from 32 tonnes of CO₂ in 1990 to just over 20 in 2020 (for a 5% reduction) or 16 (25%).

The Garnaut Climate Change Review was commissioned by Kevin Rudd in opposition and its interim report was released in February 2008. It acknowledged Australia's "exceptional sensitivity to climate change and our exceptional opportunity to do well in a world of effective global mitigation" and argued the main value of "Australia playing its full part in international efforts on climate change" would be to have "a positive effect on global outcomes" while "the direct effects of Australia's emissions reduction efforts are of secondary importance."

Garnaut advocated an emissions trading scheme and research into carbon capture and low emissions technology. The document was criticised by the Australian Chamber of Commerce and Industry for being too radical and by Friends of the Earth and Rising Tide for not being radical enough. The report did not cover deforestation, despite the McKinsey Report on Greenhouse Gas Reduction seeing forestry as the most promising sector for significant abatement by 2020.

The Carbon Pollution Reduction Scheme (CPRS) would be the most far reaching structural economic change in Australia since the free market reforms of 1980s, however its implementation remains in doubt. The Government announced on 4 May 2009 that it would delay the CPRS for a year until July 2011, due to the adverse economic situation, and offer greater subsidies to 'emissions intensive trade exposed' industries and a 'global recession buffer', but though it passed the House of Representatives on 4 June, it was later defeated in the Senate by 42 votes to 30.

The scheme is due to be represented to the Senate in November 2009, with Opposition leader Malcolm Turnbull pursuing a series of amendments to reduce its economic impact, including the permanent exclusion of agriculture, increased support for coal fired power stations and power intensive industries, such as aluminium and food processors, and help for home owners and small businesses to reduce their emissions. The Opposition believes such changes would still meet the target of reducing emissions by 5% by 2020. The Government currently intends to include agriculture after 2015 and is offering less generous support to industry. The Opposition has also signalled its support for offsets for farmers employing carbon sequestration techniques.

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The bill was opposed by several industry lobby groups, including The Australian Coal Association, and it remains to be seen what level of carbon pricing would successfully reduce demand for coal fired power and stimulate markets for renewable sources without provoking a public backlash.

In theory, the pricing of carbon offers a clear market based incentive to businesses to seek more environmentally friendly process solutions. As ever, in practice, the devil has been in the detail with regional, industrial and domestic interests haggling to maximise their subsidies and deferments before addressing their emissions. By easing the profit and employment pressure precipitated by emission pricing, subsidies to polluting industries can provide an excuse for continued inaction, rather than breathing space to facilitate change. The political will to impose a decisive carbon pricing scheme and absorb the short term political and economic consequences in return for long-term environmental benefit would be hard to maintain in the best of circumstances, given Australia's federated system and short electoral cycle, and the current financial slump and failure of the CPRS to pass the Senate does not bode well for the future of carbon pricing in Australia.

Additional political steps to encourage the evolution of a low-carbon economy are therefore vital, not only to encourage technical innovation and commercial investment, but to reduce regulatory and institutional obstacles to reform. A shift in the long-term planning of electricity transmission planning is vital, for example, to support the more distributed and intermittent pattern of power generation any significant shift to renewable will inevitably create.

The **Clean Development Mechanism (CDM)** was established as part of the 1997 Kyoto protocol and signed by Australia in 2007. It was designed to supplement, rather than replace, the need for emissions curbs in the developed world. It encourages businesses and governments in developed countries with emission caps to finance mitigation projects in developing countries and so reduce global greenhouse gas emissions at reduced cost. CDM projects earn a 'certified emission reduction (CER) unit' for each tonne of carbon dioxide or equivalent saved to offset emissions in the funding nation. Such projects must pass a threshold of 'additionality' in enabling abatement, which would otherwise not have occurred and contribute to sustainable development. More than 250 million CER units have been issued, half of them China and a quarter in Brazil and India, with nearly 70 countries accounting for the remainder. Much of the activity has centred on huge, and often controversial, hydro-power schemes and reductions in Chinese hydrofluorocarbon emissions from refrigerant production, but other projects involve wind power, methane recovery and utilisation, energy efficiency and fuel substitution, biomass and solar generation and other industrial reforms.

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The Australian Government intends to allow unlimited numbers of CER units to be surrendered against domestic emissions in its proposed Carbon Pollution Reduction Scheme. If the bill is passed, this will encourage Australian companies to invest overseas in carbon mitigation measures as the costs involved in reducing emissions from Australia's own coal fired power stations and transport infrastructure will be immense and rely on currently unproven or undeveloped technology.

The efficiency, sustainability and equity of the CDM programme are contested and may be subject to revision at the Copenhagen talks in December 2009. The absence of forestry from the programme has also been widely criticised as tropical deforestation accounts for up to a quarter of global emissions. The "Reduced Emissions from Avoided Deforestation and Degradation (REDD)" proposal would see the preservation of threatened tropical rain forest qualify for CDM project status and will also be discussed at Copenhagen.

By March 2009, 1431 projects had been registered, reducing carbon emissions by an estimated 220 million tonnes. More than 4,000 projects await certification, although past experience suggests many of these will be rejected. To put the schemes' effects into perspective, current emissions from the European Union alone top 4 billion tonnes per year.

The allied "Joint implementation" (JV) scheme allows developed countries to invest in other 'Annex I' states to reduce carbon emissions and their own liability at lower cost than reducing emissions at home. Most of these projects are based in Russia or Ukraine, whose high polluting and inefficient coal fired power plants are particularly damaging to the environment. Such investment earns an 'Emission Reduction Unit' for each tonne of CO₂ saved.



**Climate Change Protest
in Canberra**

2.6 Public Opinion

Media and political interest in an issue can be tracked by any number of indicators. For example, the number of articles referencing "global warming", "the greenhouse effect" or "climate change" in The Australian, The Age and The West Australian jumped from 20 in 1991 to over 2000 in 2006. Just one question on climate change was raised in the House of Representatives from 2002 to 2004, while none were asked in the Senate. In 2007 alone the subject provoked 54 questions in the House of Representatives and 19 in the Senate.

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One poll found that Australians were more worried by climate change in 2007 than by any other “potential threat from the outside world”, while the number who remained “relatively unworried” fell to 14%. However, in August 2009 Roy Morgan released a phone survey which, although it had a small sample size, allowed comparisons to the same questions asked in 2006, 2008 and May of 2009, and showed a gradual decline in public concern, even as the scientific data had become more urgent.

Previous experience has shown that public interest in environmental issues peaks in times of economic prosperity and plummets when more trying conditions focus personal attention on the ‘bread and butter’ issues of unemployment, inflation and health care. After the Senate defeat of the CPRS, Andrew Macintosh, an analyst from the Australian National University’s Centre of Law and Climate Policy, noted that “climate has gone on the backburner because of the economic climate we have found ourselves in.”

Although a majority still support action, the number of people who believe the danger to be exaggerated has almost doubled over the last 3 years. 83% of respondents believed carbon emissions contribute to global warming, but only 60% think them a major component and just 55% support the proposed CPRS, while 24% see the scheme as costly, disruptive and hostile to jobs.

A July 2009 “Newspoll” in The Australian revealed that 45% of voters want the Rudd Government to postpone the CPRS until after the Copenhagen conference, compared to 41% who support its immediate implementation. 8% oppose the scheme in any form. In September 2008, the same organisation found that 61% advocated immediate action and only a third wished to delay or block the scheme altogether.

Professed public concern over greenhouse gas emissions does not necessarily translate to effective personal action to tackle them at source. An October 2008 poll by the Australian National University found that 41% of respondents saw global warming as the main threat to the “future wellbeing of the world”, but only 6% said they ‘always’ cut down on personal car use for environmental reasons. Interestingly, 40% of respondents backed nuclear energy, with 50% opposed. Clear majorities advocated more government action to halt climate change, but smaller majorities signalled their willingness to pay more for water and energy as a result.

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“The global threat from climate change is now clearer than ever. The whole economy has to change.”

Sir Terry Leahy, Tesco Chief Executive

“The climate problem will not be solved by one company reducing its emissions to zero, and it won't be solved by one government acting alone. The climate problem will not be solved without mass participation by the general public in countries around the globe...”

Some of our businesses use more energy than others, but our strategy everywhere is the same...reduce our use of energy as much as possible. Then, switch to renewable sources of power where it makes economic sense. And, over time, as a last resort, offset the emissions we can't avoid.”

Rupert Murdoch
Chairman and CEO,
News Corporation,
Hudson Theatre
New York City
9 May 2007

3.1 Climate Change on the Business Agenda

Businesses are motivated by profit, rather than altruism, and respond to market incentives. They will only internalise the costs of their emissions, and therefore seek to reduce them, if there is a financial or regulatory need to do so. Part of this motivation will come from concerted international and domestic political action, but the savings to be gained from reducing energy bills and waste will also motivate business to change.

The “deep green” return to pre-industrial agrarianism advocated by some environmentalists would not only be politically unacceptable in the OECD, but would condemn untold millions in the developing world to the grinding poverty from which they have only just begun to escape. The free market is not the enemy of progress on climate change, but the most efficient engine by which it can be delivered, just as new technology, rather than the abandonment of modernity, is the key. If science can be trusted to predict and measure the emergency, it can be relied upon to tackle it.

The Stern Review notes that ‘tackling climate change is the pro-growth strategy for the longer term, and it can be done in a way that does not cap the aspirations for growth of rich or poor countries.’ Calls for austerity can only play a small part in a long-term solution based on new technology, energy efficiency and economic progress. Affluent countries in the developing world will be far better placed to deal with the effects of climate change than states still mired in poverty.

Despite its high profile, a 2008 poll by consulting firm Accenture of 500 influential companies in Britain, the USA, Germany, Japan, India and China revealed that only 10% saw climate change as a business priority. For every company which embraced their opportunities, two feared the burden of extra costs mitigation measures would impose on their firms. Most of the companies surveyed had taken some limited steps to reduce their carbon footprint, but almost 20% had taken no action at all. Only one firm in twenty, and none in China, placed climate change at the top of their priorities while just 11% of those surveyed ranked it second or third. (The Chinese Government, however, has made moves towards recognising the need to reduce emissions, pushing forward with nuclear, solar and wind power schemes and urging greater energy efficiency.)

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On average, climate change came 8th, behind the traditional concerns of boosting sales, cutting costs, developing new services and products, recruiting high quality staff, growing developing markets, pursuing innovation and developing technology. In fact, each of those traditional priorities will be instrumental in tackling climate change and pursuing new business opportunities in the low-carbon economy to come.

Many businesses still wait for Government to take the lead, unwilling to change long established practices or invest in low-carbon systems until forced by legislation. In the same survey, 60% of firms expected climate change to become a major business issue for them within five years, but over half agreed they were struggling to come to terms with the issue and its implications. Almost 70% of the companies recognised they should play a role in tackling climate change, but only 40%, and just 14% in China, saw themselves in a strong position to do so.

The survey concluded that businesses were "reluctant to make big investments in climate change-related initiatives until the scope of future regulation becomes clearer" and Mark Kenber, policy director at the Climate Group, agreed that "These disappointing findings highlight the fact that carbon pricing mechanisms are not yet strong enough for businesses to incorporate climate change risks and opportunities into traditional business strategy".

The recent financial crisis has further eroded commercial willingness to engage in what many still see as speculative or unnecessary measures as they concentrate on protecting their core business in a difficult world market. The President of the Czech Republic Václav Klaus noted that with "the sudden economic downturn, two things are becoming clear. First, it will be difficult to afford these expensive new sources of energy. Second, energy rationing policies like cap-and-trade will be a permanent drag on economic activity. Ironically, emissions have not decreased as a result of these policies, but are doing so now as the world economy moves into recession."

Although such surveys appear dispiriting to advocates of radical action, the relative tardiness of American, Chinese and other firms merely opens the way for Australian firms to seize the initiative and the competitive advantages which will result.

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3.2 The Business Risks of Climate Change

Despite corporate apathy, it is clear that both the impact of climate change and the adoption of measures to mitigate it can risk the growth, profitability and even survival of a business. The long-term inevitability of carbon pricing, by whatever means, is bound to increase costs across the board, while stricter legislation may render some commercial activities impractical, uneconomic or even illegal. It is even possible that company directors may be faced with legal challenges for personal damages, as has been the case with asbestos and tobacco companies. As far back as 2004, eight U.S. States and the City of New York filed a public nuisance suit against five of the largest American power companies in a bid to force them to reduce their emissions.

In the medium term, turmoil on financial markets, international instability and economic nationalism could jeopardise world trade. Severe weather conditions could reduce harvests, disrupt supply chains, damage equipment or reduce demand, and firms which invest or manufacture in vulnerable countries or are supplied by foreign firms must prepare alternatives in good time. The prospect of 'green' trade restrictions is already growing, with the dire consequences for international prosperity protectionism inevitably implies. The U.S. House of Representatives recently passed a climate and energy bill which provides for trade barriers against countries which balk at emission restrictions to prevent companies 'country shopping' for lower green tax regimes or less stringent regulation. In 2008, when the European Union considered restricting imports of bio-fuels breaching its environmental criteria, eight developing countries on three continents threatened legal action.

Potential regional flash points are easy to identify. Conflict between India and Pakistan over water rights from the vital Indus river basin is a major possibility. The glaciers which feed all six branches of the Indus are in decline and Islamabad, faced with a fast growing population, may well challenge the 1960 Indus Water Treaty. Given the long history of suspicion, hostility and warfare between two countries, there is every prospect such a dispute could escalate beyond mere local diplomatic wrangling.

Increased demand for water for bio-fuels could exacerbate already extant problems. Sugar cane is a more potent input than corn, but, outside Brazil, most sugar cane production requires heavy irrigation. Clean coal techniques such as the preparation of brown coal, so vital to Victoria, also require huge flows. China's economic miracle could founder on problems of population growth and declining stocks of water and arable land, and the prospect of conflict with resource-rich Russia, whose population is dwindling and whose government grows ever more authoritarian and hostile, remains.

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The Yangtze River is fed by Tibetan glaciers which are currently shrinking by 7% a year, while its low lying deltas, the font of its rice production, are vulnerable to inundation by more severe storms and rises in sea level. The Siberian Taiga, on the other hand, may become amenable to agriculture given significant warming, even as it releases vast quantities of methane, a gas 20 times more potent than CO₂ in terms of climate change.

International competition is hotting up in the Arctic where up to a fifth of the world's remaining oil reserves lay, and vanishing ice caps and higher prices have opened the possibility of drilling. Both Russia and Canada have launched major naval exercises, with Russia controversially planting their flag on the seabed under the North Pole. The United States, Canada, Russia, Norway and Denmark, the nations bordering the Arctic Ocean, have theoretically committed to abide by the United Nations Convention on the Law of the Sea in determining seabed boundaries, but confrontations over disputed areas seem more likely by the day.

Mass illegal immigration, already a major issue in Europe as economic migrants attempt to enter the prosperous E.U. from failing states in Africa and beyond, may be prompted by climatic disasters or food and resource shortages. The collapse of a megalopolis such as Lagos or Mexico City into chaos cannot be discounted while, over longer time frames, the 'brain drain' of educated, middle class elites from developing countries to sanctuary in the west would further reduce the chances of the countries they leave behind of handling the effects of climate change. Throughout the developing world, the 'green revolution' which saved millions from the starvation so confidently predicted by pundits such as Paul Erlich in the 1970s will need a successor, perhaps in the form of crops genetically modified to thrive in new climate conditions, if famine is to be averted once again. The switch of crops from foodstuffs to bio-fuels, induced by generous government subsidies, has already proved controversial for its swift and deleterious effect on world food prices and supply.

Measures to 'green the world' may reduce the dangers of climate change, but will inevitably create other sources of uncertainty. A move from gasoline to lithium-ion battery powered cars may eventually reduce the power of problem oil producing states such as Saudi Arabia, Iran, Venezuela and Russia, but will lead to competition over the world's much smaller lithium supplies. Three quarters of the world's proven deposits lay in the Atacama Desert, a desolate region shared between two countries, Chile and Bolivia, with a long history of enmity and warfare. Though the importance of oil will inevitably diminish in the long term, it is equally certain that it will continue to play a major part in the world's energy demands for decades to come.

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If coal fired generation becomes environmentally untenable, then the spread of nuclear power to new regions, with all the concerns over weapons proliferation and accidents in poorly run plants that implies, may be swift.

3.3 Business Opportunities

For all the solemn declarations at international summits and position papers produced by industry groups, the investment strategies of most businesses outside the power industry still show little regard for a low-carbon future. Carbon pricing, emissions legislation, shareholder pressure and consumer demand will eventually force restructuring in most sectors, but proactive companies have an opportunity to increase value by getting 'ahead of the curve'. Such changes of business culture are not unprecedented in kind, though past changes will be dwarfed in scale by the adjustments to come. In the 1980s, the issue of workplace safety took a long time to be recognised as a vital part of everyday business and yet is now incorporated into all operations.

Aspects of corporate responsibility, brand recognition and public reputation encourage environmental engagement, although their financial payoff is hard to quantify. Surveys of staff in the National Australia Bank suggest workers are genuinely concerned about environment issues, and companies wishing to recruit the brightest graduates should recognise that "Generation Y" assess the core values of a company in their pursuit of meaningful employment.

Long-term inexorable change is better embraced and exploited, rather than ignored, fought or evaded, and the companies which prosper in the new economy will be those which help build it today. From transport, power generation and construction to manufacturing, agriculture and mining, a recent publication by the UK Government estimated the potential world market for low-carbon goods and services at more than 7 trillion Australian dollars. A host of technological possibilities have been proposed, and huge commercial opportunities exist for companies which can successfully invent, design and market solutions, ranging from low tech wood stoves to fast breeder nuclear reactors.

Companies dependent on public service contracts should recognise that future procurement will be driven as much by environmental credentials as cost or quality. The Government already offers a range of environmental grants and rebates to stimulate demand, support innovation and fund training, and companies showing leadership will be well placed to take advantage of such schemes.

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CASE STUDY

Environment Business

Australia envisions the country as a regional 'hub' for mineral processing and manufacturing with 'mega clean energy parks' powered by solar thermal, geothermal, marine and wind energy. In addition to an ambitious national energy efficiency target, an extension of the Renewable Energy Target and the fast-tracking of soil and bio-sequestration to restore agricultural land, it advocates carbon performance standards for appliances and cars combined with a national trade-in scheme to help the public upgrade to 'cost and carbon savings'.

One perennial idea is for the state to offer large prizes for technology which can meet certain strict criteria. The invention of the H4 clock in 1714 by John Harrison, which enabled ships to calculate longitude and therefore navigate the major oceans, was motivated by a prize offered by Parliament almost six decades before. An ecological 'Mars Prize' might have a similar effect.

Given the long lead times for developing new technology, now is the time for companies to examine their investment, production and marketing strategies. If firms wait for the inevitable shifts in government legislation, investor concern and consumer behaviour, they will be left dangerously exposed to short-term spikes in asset prices or permanent shifts in demand. IP Australia examines patents in order of lodging, however, "expedited examination" is available for ideas in the field of 'green technology'. Such accelerated consideration can ensure that intellectual property is protected or encourage investors to fund further development or commercialisation.

An argument to 'wait and see' before committing to additional costs and changes to established methods will always carry clout in the boardroom. There is no established framework to understand the risks of climate change and the all important 'bottom line' has still to be affected. With carbon pricing delayed in Australia and large subsidies providing a 'soft landing' for affected sectors if it should be introduced, there may be a lessening of pressure to change. Global warming is still seen as a distant and unquantifiable risk by many, and the accountancy practice of heavily discounting future cash flows minimises appreciation of the effect a changed economic and physical environment might have. Furthermore, there is no guarantee that the Copenhagen talks will reach agreement on further cuts, or that any measures agreed will actually be implemented.

However, despite the many commercial, legal, legislative and environmental uncertainties, successful businesses already manage a wide range of risks, and there is no reason to see the latest challenges as insuperable. Environmental emergencies regarding smog, sulphur emissions, carbonylfluorocarbons and DDT were successfully tackled in the recent past at lower cost and with far less disruption than contemporary commentators thought possible.

Notes of caution can still be sounded, however. Low-carbon technologies can be expensive to develop with no guarantee of a viable market if government policy changes in the light of new scientific data, hostile public reaction or a collapse of international co-operation. Neither private industry nor Federal or State Governments are rushing to invest the huge sums required to develop and build the carbon capture and sequestration technology required to decarbonise coal fired power stations. Investment in

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renewable sources, after strong speculative growth in the early years of the decade, is stalling once again in a harsher financial climate, and banks and venture capitalists still often opt to back proven fossil fuel technology in preference to the longer lead times and uncertain returns of alternative sources.

3.4 The Export Environment

The Garnaut Climate Change Review warned that climate change will be “associated with a decline in international demand for Australia’s mineral and energy resources and agricultural products” and, as it will affect the supply of imports to Australia and demand for Australia’s exports, the reviews modelling “indicates that Australia’s terms of trade are affected much more adversely than any other developed country.”

Two thirds of Australia’s agricultural production is exported and the Australian Bureau of Agricultural Research estimates that climate change will reduce sugar exports by 79% by 2050, and beef and dairy exports by a third.

Fiona Wain, chief executive officer of Environment Business Australia, sees a \$1.3 trillion global marketplace for environmental goods and services and “if Australia can demonstrate that an energy intensive economy can retain and grow its prosperity, then we have a good opportunity to help other countries, particularly the countries in our region, with smarter technology, more energy efficiency and better infrastructure.”

As traditional export markets decline, Ms Wain envisions a bright future for exporters of renewable energy technology and sustainable goods and services. She believes that as carbon emissions become an issue for the World Trade Organisation, new environmental standards will be enacted worldwide which will have “impacts on entire supply chains from materials selection, manufacturing, transportation, warehousing, and retailing.”

Noting that Japan has already placed a carbon tax on imported coal, Ms Wain sees Australia adding value by processing more of its rich mineral reserves at home with renewable energy, instead of shipping out huge volumes of unprocessed ore. She also sees growing market for organic produce and crops produced using low till methods. **Tasmania**, for example, is already profiting from a move to niche export agriculture and the marketing of their clean energy experience. Tasmania’s higher rainfall and temperate climate leave it better placed than farms in the Murray-Darling basin and elsewhere to weather the extremes of climate change. Although long reliant on dairy, onion and potato production, its farmers are now profiting, for example, from selling Satonishiki cherries back to Japan, thanks

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to the island's freedom from the fruit flies which plague mainland Australia. Markets in poppies, wasabi (horseradish), buckwheat and genetically modified canola are also developing.

Queensland too is building on its strengths in terms of environmental architecture, launching the HEAT international marketing campaign which has already “made real impact in Europe, the US and Asia – all vital export markets for Australian architecture”, according to Howard Tanner, National President of the Australian Institute of Architects. He believes “the HEAT campaign has highlighted architects’ environmental responsiveness and adaptation to climate change and other difficult challenges, combined with their obvious expertise in tropical and sub-tropical design... When confidence returns to the global market, and it will, the work done over the past 12 months by Queensland will give firms in that state the edge when it comes to world class architecture and design commissions.”

Western Australia has boomed thanks to heavy Chinese and South East Asian demand for its enormous mineral deposits, but Adam Denniss, Austrade’s state manager, notes that in addition “we’ve seen a lot of growth in advanced technology, software and advanced services related to the resource industry.” Such expertise can be leveraged on developing global markets. “Australia would easily lead the world in a number of those advanced technologies, such as computer software systems that monitor mine sites and productivity levels. A lot of overseas companies are looking for that technology now...Countries like Brazil have all the minerals in the world, but not the technology to get it out of the ground.”

Ian Whitaker, senior trade adviser at the WA Chamber of Commerce and state manager at the Australian Institute of Export agrees that “companies that grew up in Western Australia servicing the Australian mining oil and gas sectors are now following those companies with projects around the world, to Africa and Central Asia and Latin America.” Western Australia’s small population also focuses economic growth on the export market. “There are only 2 million people in Western Australia; 1.5 million of those live in or near Perth, so it’s a very small domestic market. There’s a little bit of interstate commodity trade, but most are based at the outset that they will be 100 percent export projects.”

Adam Denniss agrees that “our isolation has forced businesses to become less reliant on people outside the state because there’s so much cost involved in dealing with people in other states. I think that’s created a natural way of thinking internationally. There’s a natural fit for businesses to look to exporting because putting something in Singapore, or going to Dubai, is equally easy for businesses in Perth as going to Sydney.”

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As in Tasmania, Western Australia's traditional agricultural exports of wool and wheat are being supplemented by international sales of wine and gourmet food, particularly "the black truffle industry in the southwest. The conditions are right and we have the opposing season to the European industry." If climate change reduces livestock and grain productivity, such high value, low bulk exports will become increasingly important.

Whittaker foresees accelerating development of Western Australia's technology sector. "We're seeing a lot of technologies start to be commercialised: they're energy sciences, energy-producing products and alternative energy products, wind power, solar power, geothermal, and solar thermal. Industrial processes are very energy hungry and managing that is very important... That's been very active in the state; people aren't necessarily exporting yet, but we're getting close. It's the next tech boom." Overall "it's becoming a much more complex logistics environment. Western Australian companies will become much more globally engaged... Western Australia and export are synonymous, it really is the most internationalised of all the state economies."

South Australia's long drought and shrinking car industry have forced it to look beyond its vines and mines and, like Western Australia, develop leading edge technology. Patricia Moessinger, Austrade's South Australia state manager, reports that "what we're seeing is growth and diversification. There's a strength in new areas of service and technology, that's the exciting part... There's ICT, water and wine technology, there's a lot of R&D going on in clean energy at the moment... South Australia has developed a real strength in water technology because of the issues with have here with lack of water. There's a lot of innovation around better use of water, more efficient use of water, clean energy is a developing industry—solar, wind, geothermal and hot rocks. They're attracted to South Australia because it's the hottest state."

The drought has already hit wheat and wine production and, with a grim agricultural future predicted in many climate change scenarios, export led diversification is vital. Water restrictions have limited grain yields, while the mining sector depends on fickle world demand, but its expertise in managing water shortages can be marketed throughout Australia and beyond as more regions begin to suffer the privations with which the state has been struggling for a decade.

Minister for Innovation Kim Carr has remarked that intellectual property protection in **the energy sector** has risen by 250% percent in the past five years, proving industry is pushing forward with green innovation to combat and adapt to climate change.

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“Patent registrations for solar and clean coal technology applications from Australian and overseas innovators have risen by 15 percent and 50 percent respectively over the past five years... Combined with the huge jump in green trade marks in the energy sector, these figures clearly show that innovators are tackling climate change head-on.” Minister Carr noted that Australia’s intellectual property protection “allows Australia to benefit from investment in green technologies by protecting that investment, and licensing the technology to other countries.”

Following the Federal Government’s three year, \$14.9 billion commitment to its clean energy trade and investment strategy, AusTrade and Enterprise Connect held “Clean Technology for the Future” road shows in Perth, Canberra, Melbourne and Sydney in June 2009. These promoted Australia’s potential to become a world leader in clean energy, given its proven expertise in renewables, green buildings, efficiency and sustainable water technologies.

Firms seeking to export to South East Asia and beyond, however, cannot expect that successful domestic marketing strategies will work just as effectively abroad. Whatever the veneer of globalisation, cultural norms and purchasing triggers can vary greatly, and careful research is needed to maximise the opportunities.

Mohammad Khan, Australia Post’s international business development manager in New South Wales, underlines the point. “Many SMEs think if they are successful domestically, they will be successful internationally, but they need to work on the target market, that is, culture, language, branding, pricing, competitive positioning, product life cycle, climate conditions and local marketing regulations... One key factor for succeeding in a new market is understanding the local requirements and marketing it to the right audience.”

The existence of competitors should not dissuade SMEs from seeking export opportunities, as it signals an established market, so removing any need to educate and create a market from scratch. Nick Scott, lecturer in international business at the University of Western Sydney, observes that “Essentially SMEs are market takers rather than market makers. Foreign consumers are very different from Australian consumers in where they see value, so you have to look at your product and what triggers their purchasing behaviour.” For all the pitfalls of language translation and disparate cultural sensitivities, the Australian brand can be a powerful factor to encourage sales. Mr Scott underlines that “incorporating Australian symbols and references is a way to gain the country of origin benefits because we’re seen as clean and green.” The Australian Made, Australian Grown campaign has also positioned Australia as a producer of eco-friendly products.

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3.5 CDM Related Australian Investment Opportunities in South East Asia

The signing of the Kyoto treaty, the Australian Government's signalled acceptance of CER units as offsets in its proposed CPRS, and the potentially high cost of carbon mitigation measures in Australia all argue for major investments by Australian firms in renewable energy and carbon reduction projects in South East Asia, where there is clearly great scope for carbon limitation at relatively low cost. It is to be hoped that measures to protect the fast disappearing tropical forests of Indonesia, currently being burned, logged or cleared for palm oil plantations at a dizzying rate, will also be incorporated into the CDM scheme at Copenhagen.

The fast growing countries of South East Asia are now some of Australia's most important trading partners, but many of these states are highly vulnerable to the effects of accelerating climate change. Despite the global economic downturn, governments in the region have signalled their willingness to encourage renewable energy, emission reduction and climate change adaption strategies to protect their populations, economies and environment from possible water shortages, rice crop failures, inundation of island and coastal communities and resurgent tropical diseases. The Philippines, Thailand and Vietnam are particularly vulnerable, given their reliance on agriculture, forestry and other natural resources. Australian businesses seeking to mitigate their liabilities under the proposed CPRS at optimum cost should proactively investigate investment opportunities in programmes in energy efficiency, clean transport and renewable sources including solar, wind, biomass, hydro and geothermal.

A report published by the Swedish International Development Cooperation Agency highlights the opportunities for foreign firms to take action, as private companies in the region still show little sign of acknowledging, let alone reacting to, the need to reduce carbon emissions. The publication notes that "Climate change presents several major challenges for business with operations or customers/ suppliers in South East Asia" and warns foreign firms that "distant climate impacts may affect business if suppliers' operations are disrupted. Operational risks also come from disruptions to infrastructure - if roads or railways are damaged or submerged, supplies cannot come in and finished good cannot go to the market."

The regulatory incentives to build **environmentally friendly buildings** in fast expanding South Asian cities are currently lacking, with Ranjith Perera, professor of urban environmental management at the Asian Institute of Technology in Thailand observing that "many governments do not touch the real estate sector because it brings in a lot of investment."

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The lack of planning regulations and ‘green belt’ protection has led to unchecked urban sprawl “with the line between urban and rural areas being blurred” and so “Mega-urbanisation is the result.” The report observes that climate change will leave people in such megacities vulnerable to higher temperatures, rising sea levels and floods and that “major cities such as Bangkok, Ho Chi Minh City, Hanoi and Jakarta risk becoming submerged within this century”. Manila in the Philippines and the tourist centre of Phuket in Thailand are already facing water shortages. “We are at the stage where many of the effects of climate change are unavoidable, especially in South-east Asia,” confirms Kirk Herbertson of the Washington D.C.-based World Resources Institute. “Business should acknowledge the risks of climate change, but should also acknowledge the opportunities climate change offers.”

Given Australia’s experience in **renewables, green buildings, energy efficiency and sustainable water technologies**, its companies are ideally placed to exploit new investment possibilities. South Korea, for example, has just embarked on an ambitious and expensive environmental programme to build a million ‘ecohomes’ and develop alternative energy and water supplies. Not all trade is so environmentally friendly, however, with the Victorian Government having to balance job and revenue considerations against the potential for environmental damage in weighing the application of Exergen to sell \$700 million of brown coal to India.

The Energy Information Administration calculates that the carbon emissions of developing countries will outstrip those of developed nations by 2025. Measures to limit such emissions are vital if global climate change is to be stopped and Australian firms, given the development of mitigation measures in Australia, are ideally placed to share such techniques and technology worldwide. 70% of all carbon emissions are energy related and developing countries have significantly higher energy and carbon emission intensities than OECD countries, as well as higher growth rates and heavier dependence on fossil fuels. Coal accounts for over 50% of power generation in India, and the share of fossil fuel use ranges from 99% in Bangladesh to 45% in Bhutan.

Potential **CDM projects in the Asian industrial sector** include the iron, steel and cement industries, power co-generation, the sugar, paper and pulp industries, more efficient brick kilns and electricity demand-side management programs. The further development of hydro-electric schemes in Nepal and Bhutan, gas in India, Pakistan and Bangladesh and the switching from oil and coal to gas in transport, industrial boilers and domestic cooking are all promising avenues for Australian investment.

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The use of **alternative transport fuels** such as bio-diesel, ethanol and methanol, and, in the medium term, electric vehicles, supplied with non thermal power, electric ropeways and mass rapid transit systems in large cities all offer burgeoning export opportunities.

In **the residential sector**, Australian firms should seek opportunities in promoting biogas for cooking, fuel efficient stoves and invest in biomass plantations on currently denuded ground for fuel wood. The use of solar water heaters, of which Australia has a long history, is also ripe for development, and sales of efficient air conditioners, refrigerators and lamps are all set to enjoy rapid regional growth in the future. Better urban and agricultural waste management techniques, in particular methane capture schemes, would reduce emissions, generate electricity and reduce water and air pollution and is another area in which Australian firms have particular experience.

There is a 9% discrepancy between the efficiency of most **Asian coal fired power plants** and modern Australian and best-practice OECD stations, and the transfer of technology and techniques to improve the performance of existing plants could reduce emissions substantially. Given Australia's reliance on coal fired electricity and the steps being taken domestically to mitigate these emissions, the leveraging of Australian expertise could be a profitable and effective proposition, particularly in return for CDM credits.

Losses incurred by **poor electricity transmission and distribution** are also significant, ranging from 14% in Vietnam to over 30% in isolated Burma. Such losses can be reduced to under 10% with better design, maintenance and management, and Australian expertise in maintaining systems over long distances in rough terrain could pay dividends. An improvement of Pakistan's grid of just 1% from 1995 to 2018 would reap savings of around 25 million tonnes of carbon dioxide. Gross savings per kW are normally higher than the cost of the new investment required.

Lighting accounts for 28% of India's residential power use, 32.8% of Pakistan's and 32% of Sri Lanka's. Incandescent bulbs are still common in Asia, despite using 3 to 4 times more power than compact fluorescents. Australia was one of the first countries to move to ban old fashioned bulbs and can leverage this experience to promote their adoption through the region.

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Air conditioning consumes much of the power used by the commercial sector in Asia, ranging from 20% in Pakistan to 70% in Thailand. Until recently, the units commonly used in Thailand used almost half as much energy again as the most efficient models in Australia. Australia's reliance on air conditioning is ubiquitous and its adoption of low cost, high efficiency systems puts it in a good position to market such systems in Asia. The standard motors used for pumping water and industrial drives in India, Thailand, Pakistan, Vietnam, Indonesia and Sri Lanka are also less efficient than those produced in Australia and the potential for retooling is clear.

China has a particularly bad record regarding the efficiency of its huge **cement industry**, by far the largest in the world. A tonne of Chinese cement required 5.8 gigajoules (GJ), in terms of fuel and power for limestone calcinations, in 1995, compared to a best-practice target of 3.8 GJ. Up to 260 million tonnes of emissions could be achieved if such efficiency was generally attained. Techniques the Australian cement industry is adopting or considering, including the substitution of clinker by mineral waste and the use of biomass and waste for power generation, should prove scalable to Chinese conditions. Increasing the fly ash content in cement from 10% to 13%, for example, would save 12,277 tonnes of carbon dioxide for every million tons of cement produced.

In a similar vein, best-practice **steel production** in India would save 16.8 GJ per tonne and 16.5 GJ per tonne in China. If India improved the energy intensity of its steel industry by 10%, it would save the equivalent of 4.6 million tonnes of coal per year. The injection of pulverised coal into primary steel blast furnaces, the recovery of heat from sinter plants and heat and process gas from coke ovens, blast furnaces and basic oxygen furnaces are all techniques Australian firms could assist with. There is great scope for the replacement of open-hearth with basic oxygen furnaces and the application of continuous and thin slab casting for primary steel while secondary steel production could be improved by the pre-heating of scrap and ladles and the injection of oxygen and fuel in electric arc furnaces.

The building of vertical shaft **brick kilns**, which use from 10 to 13 tonnes of coal per 100,000 bricks, would produce substantial savings over fixed chimney (16-20 tonnes), Bull's Trench (20-24) and Clamp (30-48) kiln designs.

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Australia has a large **sugar cane industry** and is taking steps to improve the sector's co-generation capacity. Indonesia (31 million tonnes of sugar cane produced in 2004), the Philippines (21 million tonnes), Thailand (54 million tonnes) and Vietnam (12 million tonnes) have the combined potential to produce 11,407 gigawatt hours per year from sugar cane biomass waste, if their co-generation potential was fully exploited. These countries also have huge and growing palm oil plantations, producing approaching 70 million tonnes of palm oil per year. This generates almost 30 million tonnes of residue which, if used as biofuel, would generate 11,693 gigawatt hours a year.

India has a solar potential of 7 kWh per square metre and could produce 20,000 megawatts of wind power, 17,000 mw from biomass and 10,000 from mini-hydro schemes and yet in 2003 produced just 57 PV of solar power, 1702 mw through wind, 98 mw from biomass and 217 mw from mini-hydro. Given the serious environmental impact of its large and growing coal generation sector, the potential for Australian technology and expertise to more fully exploit India's **alternative energy sector** is clear.

Other countries, from Nepal to Sri Lanka, have similarly undeveloped alternative power industries. India will require vast investment in its energy infrastructure in the coming decades to power its growth, and Australia should position itself to reap the benefits. It should be remembered, however, that the marginal abatement costs per tonne of CO₂ vary greatly not only between sectors, but within them. Based on a study of CDM projects in Yunnan in China, India, Sri Lanka, Thailand and Vietnam in 2003, costs varied from \$12 to \$364 for solar schemes while hydropower schemes cost only \$2 compared to up to \$36 for wind power. Geothermal costs varied from \$5 to \$73 per tonne of CO₂ while BIGCC costs ranged from \$3 to \$95. Australian firms need to effectively analyse the likely returns of such projects to ensure maximum value from their investment.

Fugitive emissions from **gas production** are still high in several countries including Indonesia, Azerbaijan, Malaysia and Pakistan and, given Australia's experience of natural gas generation, the opportunity to leverage best-practice technology and techniques is clear. Malaysia, Sri Lanka and Kyrgyzstan produce significant emissions from solid and industrial waste while the Philippines, Thailand and Malaysia suffer from high rates of forest and grassland destruction. If forest offsets become eligible for certification, this offers another large market for Australian investment.

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It should be remembered that not all energy efficiency and alternative energy projects qualify for certified emission certificates, and low market demand and a depressed price for CERs do nothing to encourage investment. Furthermore, the passing of the CPRS in Australia is still in doubt, leaving Australian companies uncertain as to whether they will need to seek overseas opportunities to mitigate their carbon emissions.

CASE STUDY

Through its proactive environmental management system, **Godfrey Hirst Ltd**, the largest carpet maker in the Southern Hemisphere, has reduced its greenhouse gas emissions by 35%, water consumption by 60% and waste by 35% per metre of carpet produced.

3.6 A Business Climate Strategy Plan

Entire industries will be created, changed radically or destroyed by the low-carbon economy, just as they were by the coal fired industrial revolution. Agriculture is threatened by desertification, aluminium smelting by its huge energy demands, coal mining and power generation by their carbon emissions, the insurance industry by large claims made for extreme weather events and tourism by air travel restrictions and the loss of attractions such as the Great Barrier Reef. Other industries will suffer 'knock on' effects, with miners of raw materials, for example, facing competition from recycled stock.

Individual firms have tended to allow industry bodies to take the lead and, given the inevitable compromises involved in forging consensus, such groups invariably trumpet their commitment to change in theory, while hedging a minimalist approach in practice. Decisive leadership must come from CEOs and the boardroom and, though no one company can revolutionise public or industrial attitudes, each player can make a measurable contribution. There is no shortage of advice or support. Business networks such as local Chambers of Commerce are increasingly proactive, with, for example, the Sydney Carbon Group promoting Australia and New South Wales as centres of excellence in the field of fighting climate change.

Just as signals move markets, a clear declaration of intent to reduce emissions and improve environmental standing can bear instant results, if communicated properly to staff, suppliers and customers. The appointment of a specific employee can drive the process in a smaller firm, while a climate action team in a larger company should include representatives from all interested departments including human resources, operations management, design and product/service development, procurement, marketing and accounts. The team must then set specific and measurable targets to provide criteria against which progress can be calculated.

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Companies should build a “carbon fact base” regarding their operations and identify relevant low-carbon drivers such as carbon pricing or emissions and recycling legislation. They should develop future scenarios, evaluate the deployment of low-carbon strategies and, through rigorous cost benefit analysis, select and implement the best options for change. Calculations of cost, revenue and competitive differential will apply to carbon emissions in the future just as they do to factors of production today, but companies which can clearly demonstrate their commitment to change will attract more private and public investment to fund such reforms and bolster their market position.

Though some will be born of legislative necessity, many reforms will be motivated by profit. A thorough analysis of business structure and practice may reveal opportunities to improve operational efficiency and new revenue streams from emissions trading, government grants and ‘green markets’. The balancing of corporate portfolios opens up potentials for arbitrage through the divesting of carbon intensive stock for low-carbon companies, while improvements in public image and visibility flow from taking a ‘green’ stance with consumers. The restating of a company’s ‘vision’ to include low-carbon priorities and sustainable development, the development of environmental targets and indicators and co-operation with suppliers and vendors to establish a ‘green’ supply and product chain can emphasise a company’s environmental credentials as can the conspicuous adoption of voluntary charters and support for industry initiatives.

Although some reforms may require major capital investment with long term, or ultimately uncertain returns, whatever the complexity of an individual firm’s carbon profile, there are many simple, immediate steps which most companies can take to save energy and enhance their green credentials. ‘Reduce, reuse and recycle’ applies as much to office stationary or canteens as massive manufacturing plants. Simple and obvious steps such as encouraging employees to turn off lights and close doors can reap sizeable benefits as employees tend to be relatively wasteful of energy at work as they do not foot the bill. The installation of compact fluorescent lights, energy efficient boilers and the energy management of heating and air conditioning systems can slash costs with little effort or additional expenditure. Tree planting on company land is another conspicuous way to publicise a firm’s environmental commitment.

Climate Strategy Planning which calculates a company’s greenhouse emissions, manages risks and opportunities and identifies cost effective abatement strategies is useless, if the measures are not properly applied and amended in the light of operational experience. It is vital therefore to consult with shareholders, employees and other stakeholders when implementing such a plan to gain their active support.

PART THREE - Risks and Rewards

The canvassing of suggestions from the factory floor is often highly productive as such workers are best placed to observe wasteful practices. However, if employees are constantly challenged to find new ways of reducing emissions and targets remorselessly increased, then fatigue and irritation with the process may set in, if not balanced with incentives, prizes and rewards. There is also a need for greater transparency and information when promoting climate change reforms to employees or customers. Energy saving measures can seem self interested “penny pinching” if not rewarded and placed in the overall context of environmental action, while a plethora of ‘carbon offset’ schemes have been offered by airlines without, in some cases, precise details of where the money raised would be spent and how it would help the situation.

CASE STUDY

In the last six years Foster’s Cascade Brewery in Tasmania has cut greenhouse emissions by 16% and reduced water usage by 30% per unit of production. All greenhouse emissions attributed to its new ‘Cascade Green Beer’ - from picking the hops to recycling the bottle - will be offset, meaning its net carbon impact is zero.

Australian companies can follow best international practice as well as lead their own change. One clear lesson to be learned is that incremental, but generally applied reforms have proven their ability to make substantial contributions without compromising core business or methods of operation. Most business ideas fail in their first year and the majority of schemes to address climate change will fair no better, but the abandonment of any particular approach will not invalidate the need to take action overall. Even minor, short term measures can have long-term and significant effects as once energy saving habits are instilled in the workplace through new rules or exhortation, evidence from the domestic sphere suggests they will remain ingrained long after oversight is relaxed. Water restrictions in South East Queensland and elsewhere, for example, show that when householders plant ‘water smart’ gardens and take shorter showers in time of drought, their water consumption does not increase to its former levels when the restrictions are relaxed.

The largest American paper company, International Paper Co, increased its use of wood waste from 13% in 2002 to over 20% today to pare down emissions and energy costs, while as far back as 1994, the chemical giant DuPont pledged to reduce its carbon emissions by 40% of 1990’s levels by the turn of the century. Once this was achieved, it aimed for a 65% cut by 2010 and has already hit that target. DuPont produces 30% more goods than in 1990, but uses 7% less energy to do so, a saving of \$2 billion US.

Geneva’s STMicroelectronics found several simple and inexpensive methods to save \$173 million US in energy costs with measures as simple as installing larger air-conditioning ducts to allow fans to operate at lower speeds cutting a seventh of their energy requirements.

PART THREE - Risks and Rewards

CASE STUDY

In 2008 research firm Reputex listed what it regarded as **Australia's most carbon friendly companies** by comparing emissions to turnover.

The highest performing companies in each sector were Billabong and News Corporation (Consumer Discretionary), Foster's Group (Consumer Staples), Arrow Energy and Queensland Gas Company (Energy), Westpac (Financials), Cochlear (Health Care), Transurban Group (Industrials), Computershare (Information Technology), Sims Group (Materials), Stockland (Property Trusts), Telstra (Telecommunications) and Babcock & Brown Wind Partners (Utilities).

Their 'Carbon Leaders' stock index follows 44 S&P ASX 200 stocks and has consistently outperformed the market, indicating that "carbon optimised" firms can offer more value to investors. Head of Research Hugh Grossman believed it to be a simple equation "These companies will be better insulated from any carbon tax, and better positioned to benefit from constraints on competitors. Other stocks will simply be playing catch up."

In the UK, Booz & Company analysed hidden carbon emissions in the snack food supply chain and found that, as European potato suppliers were paid by weight, they had an incentive to control humidification to produce moist, heavy potatoes. The extra cooking required to remove the extra few grams of water per potato was significant, and changing procurement contracts to eliminate this extra hydration would cut 10% from crisp frying costs and save 9,200 tonnes of carbon output per year.

Dr Greg Lavery, Senior Associate with Booz & Company in Sydney, notes that "In a carbon-constrained environment, energy efficiency measures represent the low-hanging fruit for companies wanting to reduce any direct emissions liability or exposure to rising energy prices... But we see even greater potential for shaving emissions by examining energy consumption across the entire supply chain, from raw materials through to transport, manufacture, distribution and waste recycling. This whole-of-supply approach represents fertile ground for identifying the cuts in emissions the Australian Government's Carbon Pollution Reduction Scheme will demand."

"We have seen some unexpected findings from this sort of analysis. For example, some clothing retailers have recognised that the greatest emission savings over the lifetime of a garment can be made by consumers washing in cold water - so they have recommended this on the washing instructions. We are convinced there are similar surprises hidden away in many industry supply chains. In this way, supply chains are a wealth of emissions savings waiting to be tapped – all that is required is some close analysis and co-operation between manufacturers and their upstream and downstream suppliers."

3.7 Short, Medium and Long Term Business Strategies

The decision to take action is a business imperative and can deliver immediate financial benefits, robust growth in the medium term and assure survival into the future.

Certain major industries, such as oil and power, are well aware of the need for change despite the technical difficulties, high cost and long lead times required to re-equip the infrastructure of tomorrow. Energy hungry manufacturers, such as cement, aluminium and steel, will also be forced to adapt, particularly if the CPRS is passed, as will agriculture, insurance, tourism and other sectors set to be directly affected. All companies, however, use energy and rely on transportation either directly or through their supply chain and therefore must devise short, medium and long term strategies to reduce their carbon footprint and seek new markets.

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More stringent climate regulation, spiralling energy prices, and the increasing focus of public, political and investor interest on the issue are business considerations which cannot be ignored or wished away. In the short term, firms must seek to limit their costs and research preparations for a carbon-constrained world. In the medium term, they must carbon optimise their production and organisational processes while taking advantage of green markets and, in the long term, they must contemplate radical transformation and even diversify entirely from their traditional sector of operations.

In the short term: The impact of climate change on the country, its trading partners and demand and supply is still at an early stage, and the international framework of emissions targets and regulation could develop new directions at Copenhagen and beyond. Regardless of wider developments, a commitment to reduce greenhouse gas emissions should lead to immediate energy savings, although these must be offset against the cost of future capital investment in low carbon retooling and equipment. The drive to reduce energy use can reveal opportunities to optimise processes that would not otherwise have come to light, and all savings in energy, materials and transportation bring immediate benefit to a company's bottom line. Measures as simple as upgrading lighting and shutting down machines and computers when not in use can have immediate impact on both emissions and costs. While it would be absurd to scrap a relatively new fleet of service vehicles, a switch to bio-fuels and a rationalisation of delivery and supply journeys can be made without significant capital investment.

The public declaration of a company's environmental stance and its publicising through transport and product branding, internal employee communications and press updates can have a beneficial effort on corporate reputation, although eloquent statements of concern and intent must be backed up by practical and comprehensive action in the medium term to avoid the charge of 'greenwashing' business as usual. A targeted programme of market research should also identify new market opportunities in the developing green consumer and product sector. Close attention should be paid to trends in consumer preferences, trends in the media, community concerns expressed through interest groups and proposed regulation.

The immediate requirement to undertake a thorough assessment of greenhouse gas emissions and consequent opportunities for process optimisation will offer boardroom and shareholders a firm financial rationale for medium term investment in new technology. Not all greenhouse gas reduction strategies will prove economically viable or practical in operation, and rigorous cost /benefit analysis and study of best practice at home and abroad is required to sort the wheat from the chaff.

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CASE STUDY

Queensland company **Little Green Genie** has launched a unique piece of climate change software to calculate the emissions liability of a computer in use and automatically purchase the appropriate amount of carbon offsets to neutralise its impact on the environment. "We think the public really feels a sense of duty to help offset carbon emissions, but many feel it can be too much of a hassle to really do anything", said a company spokesman. "The Little Green Genie program.... is easy to download and calculates the computers emissions for energy use." The tool was praised by the Hon. Kate Jones MP, Queensland Minister for Climate Change and Sustainability, who congratulated the company on "developing such a simple and effective tool that can make reducing our carbon footprint easier."

The lobbying of domestic political interests with a view to shaping future policy may also be contemplated. Companies which can influence legislation will inevitably help frame practice which is economically beneficial to them, if not their competitors. BP won an advisory role in designing the British emissions trading system, for example, while Shell's experience with their internal trading desk saw them given an advisory role in the creation of the European Union Trading Directive.

For investment to be made into new low-carbon goods and processes in the medium term, new sources of capital have to be found now. The Australian Government already offers a wide range of grants and benefits to companies involved in researching or adopting alternative energy and other low carbon technology. The scoping of opportunities for low cost overseas mitigation of carbon liabilities is important if the CPRS goes ahead.

The medium term must see firms incorporating climate change into their risk management calculations and factoring the issue into all their business planning decisions. Whatever the uncertainties of the future, senior board members would be negligent, if they did not factor the physical and financial risks involved from droughts and floods to the effect of carbon liabilities on share price and asset valuation. The results of initial carbon surveys and emission profiling must be translated into practical change on the shop floor.

Investment in new process machinery must be made, even if product lines remain largely unchanged. In terms of transport, for example, the initial switch to biofuels and the rationalisation of journeys should lead to the re-equipping of service fleets in the medium term and the switching to low-carbon suppliers where practicable. The simple inclusion of energy efficiency specifications when obsolescent machinery becomes due for renewal can reap dividends, and government assistance is often on hand for retooling which can be proven to be of environmental benefit.

Companies should exploit the new market trends initially identified. Whether that is the 'greening' of existing brands or finding new 'green' applications for existing products, there are few companies which cannot put a 'green spin' on their existing business to seek to gain market advantage. The low-carbon economy will generate supply and demand for emission-reducing technologies, new financial instruments for emissions trading, novel mechanisms for transferring technologies globally through the Joint Implementation and the Clean Development Mechanism and growing pressures to retire legacy sources of greenhouse gases and all must be exploited if a company is not to be left behind by events and its competitors.

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A genuine root and branch effort to improve a company's environmental performance can have beneficial effects on the workforce and improve human resource management as the change in culture required and its promotion of teamwork and individual responsibility has pay offs in all areas of production. The deployment of reporting and reward systems, the impact of improved training and above all the necessity to seek, value and act on employee input from every level will improve morale and productivity and attract and retain a high quality and committed workforce.

In **the long term**, the integration of climate change and business strategy may mean that companies are forced to downscale or phase out existing products and diversify into fresh areas. Oil companies such as BP are pro-actively positioning themselves as 'energy' companies, rather than fossil fuel suppliers, in their public pronouncements and branding, and such stances will become a reality in the long term as reliance on petrol powered vehicles declines in favour of alternative fuels. Sustainable climate-related strategies cannot be an add-on to business as usual. Instead, climate-related strategies must be integrated into a company's overall business strategy to the point of driving it for success.

Australian agriculture and industry have undergone such systematic change throughout their relatively brief history. A century ago, wool accounted for 40% of exports while as late as the 1960s, exports were still centred on wool, agriculture and minerals. These sectors are still the backbone of the economy, but Australia can boast, for example, eight Nobel Prize laureates in medical sciences and a string of world-beating biotechnology innovations such as the anti-viral drug Relenza and the cervical cancer vaccine Gardisal. Australia has demonstrated cutting edge capabilities in a wide range of new technology from ICT and nanotechnology to environmental management and avionics, and such scientific and engineering talent will reap rich dividends if directed to the needs of renewable and low-carbon technology in the long term. The shift from traditional markets in Britain, Japan, the United States and New Zealand to the Pacific Rim, particularly China and other fast expanding economies in South East Asia, will only be exacerbated by the need for these energy hungry countries to invest in renewable technology. China, for example, is considering investing up to \$560 billion in alternative energy capacity.

Australian firms must follow the examples of major corporations elsewhere if they are not to be left behind in the race for carbon reform. The American firm Du Pont, for example, is engaged in a fundamental shift of technology, not least in the manufacturing of bio-mass feed stocks and the creation of new polymers. The aluminium firm Alcoa is fast expanding its use of recycled aluminium, which uses only 5% of the energy of primary aluminium.

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The demand for lighter vehicles will only spur demand for the metal, and sourcing it from low energy processing makes sound commercial sense. The possibility for Australia's car industry to play a prominent role should not be overlooked. Barely any cars were exported as late as 1980, while 40% of current output is currently sold to foreign markets, especially in the lucrative Middle East. The present government's substantial investment in green car research underlines the potential of this sector; particularly as traditional petroleum car production has suffered badly in the current economic downturn.

CASE STUDY

CarbonView™, a carbon management solution by the Australian supply chain integration company **Viewlocity Technologies**, enables companies to implement pragmatic green strategies, while simultaneously improving their business performance. CarbonView™ is the first solution in the world to provide organisations with a complete solution to measure, monitor and optimise a company's carbon footprint in the extended supply chain.

3.8 Supply Chain Carbon Management

The need to contain costs in the supply chain is more pressing than ever in the current economic climate, and such efforts can complement, rather than undermine, the drive to reduce carbon emissions and improve environmental standards. Eye For Transport's Green Transportation & Logistics Report found that up to three quarters of a company's carbon footprint can be generated merely by transportation and logistics. A strategy to optimise the supply chain in terms of carbon emissions can also serve to improve cost and operational efficiency, and such reforms need not rely on heavy capital investment or the adoption of exotic technology.

An IBM paper by Keith Burgess and Simon Glass notes that supply chain carbon liabilities can be reduced with a number of common approaches, including the local sourcing of parts and raw materials to reduce transportation expenses and the use of fuel efficient vehicles.

The redesign of products to minimise weight, complexity and energy costs can eliminate whole portions of an existing supply chain, while a reduction in unnecessary packaging is another obvious and less drastic solution, although government regulations often mandate its use to protect food and other goods. Furthermore, damage to goods in transit wastes a great deal of energy and resources as such goods must be laboriously returned and replaced. The use of logistics bars and air bags between pallets can significantly reduce the number of damaged shipments, while improving customer service and satisfaction.

A renegotiation of service terms, encouraging customers to accept larger, less frequent deliveries can further cut costs and emissions and ensure that transport assets are used to capacity. An improvement in the rates of first time delivery can be achieved through personal interaction between driver and customer through texts and mobile phone.

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The concept of 'food mileage' has been much invoked by environmental campaigners, however, the issues are often more complex than a simple calculation of distance might suggest. Food that has been locally grown in heated greenhouses, for example, will have a higher carbon footprint than crops grown in natural conditions some distance away. The rationalisation of transport can also be achieved by other means. UK Supermarket Tesco took the simple step of adapting its trailers to allow both the pick up of pallets from suppliers and the delivery of roll-cages to stores for purely operational reasons and at a stroke reduced the distance travelled by its lorries by 3 million miles, cut their fuel consumption by 1.7 million litres and saved 4,600 tonnes of greenhouse gas emissions.

The importance of product life cycles is developing now that manufacturing liability no longer ends when the product leaves the factory floor. Goods, which may be recalled from customers require upgrading over time or demand particular disposal techniques, create a 'reverse supply chain' which should be planned from the outset, rather than improvised ad-hoc when necessity dictates.

Companies must analyse their supply chain in detail, measuring the environmental and cost implications of each stage. Such metrics allow benchmarks to be established, which can be compared to the results of reforms, allowing them to be further refined and rolled out in other areas. One environmental and cost 'hot spot' is the use of expensive and environmentally inefficient courier or airfreight services for 'one off' items by individuals not accountable for their cost. The use of information technology to share information and track goods in transit can save any amount of remedial physical freight.

Refitting and renegotiating a supply chain can be a complex process, involving any number of choices and processes, each of which has personal and commercial implications as well as environmental effects, but in the improvement of processes, rather than the imposition of random cuts, is the key to maximising supply chain efficiency and minimising costs and emissions. Green initiatives not only improve a firm's environmental standing, but boost both profits and customer satisfaction.

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CASE STUDY

In July 2009, **EDS and SAP Australia and New Zealand** announced a new carbon accounting solution to help Australian companies comply with new Federal government emissions guidelines. The SAP Environmental Compliance (EC) solution is an enterprise-wide software platform that allows corporations to define regulatory scenarios with key performance indicators.

3.9 Carbon Accounting

“In the future I expect a company’s carbon statement to be as prominent as its financial statement.

That’s because investors are demanding reliable information about a company’s global carbon footprint, as well what it’s doing to reduce its CO2 emissions.

Proper financial reporting is a no-brainer.

Carbon reporting must be the same.”

Ian Pearson, former UK Minister of State for Climate Change and Environment

In 2007 the Government introduced the National Greenhouse and Energy Reporting (NGER) Act which established a national framework for 700 medium and large Australian companies to report on greenhouse gas emissions, reductions, removals and offsets, energy consumption and production. It is generally accepted that the Government must set firm targets and offer tangible incentives for carbon accounting to succeed. If genuine value cannot be assessed or realised, the speed of innovation will stall and the process remain ineffective.

The Greenhouse Gas Protocol of the World Council for Sustainable Development and the World Resources Institute offers an accounting tool for managers to understand, quantify, manage and report greenhouse gas emissions. Without the ability to measure a variant, it cannot be effectively controlled. The protocol stresses five fundamental factors to drive a company’s assessment, namely completeness, consistency, transparency, accuracy and the ability to be maintained. The International Organization for Standardization also provides general emissions standards for organisations (ISO 14064 - 1) and projects (ISO 14064 - 2) while specifications to validate and verify relevant accounts are laid out in ISO 14064 – 3.

A plethora of carbon accounting techniques are being developed to provide rapid, accurate and cost effective processes for collecting, analysing and reporting greenhouse gas emissions. Process lifecycle analysis (LCA) can be engaged to produce assessments of product emissions, eutrophication and toxicity, while Input-Output LCA uses industry based environmental data to build databases of environmental impacts. Australia's own National Carbon Accounting System assesses greenhouse gas emissions from land use change and agriculture through an integrated system of satellites, management, climate and soil data and spatial and temporal ecosystem modelling.

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4.1 Towards a Low-Carbon Economy

Australia's rejection of nuclear power and the limitations of renewable sources ensure that coal generation will continue to dominate its electricity supply and, with carbon capture in its infancy, major changes will have to be made across the whole of the economy if the country is to meet its domestic aims and international obligations and forge a sustainable low-carbon future.

Low-carbon proponents claim such a transition can be achieved at manageable cost with little long-term effect on growth, although others believe only the abandonment of capitalism, consumerism and an industrial society will suffice. Research by the Carbon Trust and Imperial College in the UK argues that a 60% reduction in carbon emissions can be achieved by 2050 through the adoption of energy efficiency and renewable sources of electricity and the substitution of coal and oil with gas and hydrogen. The UK's official Committee on Climate Change calculated in "Building a Low-Carbon Economy" that cutting emissions to 80% of 1990 levels by 2050 could be achieved at a cost of 1 to 2% of GDP, the equivalent of six months to one year's growth.

In the short term, the transition relies less on breathtaking scientific breakthroughs than the widespread adoption and refinement of known technology, opening immediate business opportunities for savings and new markets without relying on speculative, long-term research.



4.2 Energy

Fossil fuels generate the overwhelming majority of Australia's electricity, with coal-fired power stations dwarfing the contributions of natural gas (13.8% in 2003), hydropower (7.0%), oil (1.0%), biomass (0.6%) and solar and wind (0.3%). Rationalisation of the system is clearly required as the current patchwork of federal and state regulation can overlap or contradict in intention and complicate planning and operations for energy firms, although mandatory disclosure of energy efficiency was recently proposed by the Council of Australian Governments (COAG) to take effect from May 2011. Coal and gas are projected to account for 35% and 25% of energy needs in 2050, with renewable sources including solar, wind, wave and geothermal providing the balance.

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The International Energy Agency estimated that in 2001 the average Australian used 10.3 thousand kilowatt hours of electricity per year, compared to an OECD average of 7.9. The COAG National Framework on Energy Efficiency Group believes energy consumption could be reduced by up to 30% merely by the use of current technology in all circumstances.

“A revolution in humanity’s use of fossil fuel-based energy would be necessary sooner or later to sustain and to extend modern standards of living. It will be required sooner if we are to hold the risks of climate change to acceptable levels. The costs that we bear in making an early adjustment will bring forward, and reduce for future times, the costs of the inevitable eventual adjustment away from fossil fuels.” (Ross Garnaut at the 6th Arndt Memorial Lecture, The Australian National University, Canberra, June 2008)



CASE STUDY

The ZeroGen Project is leading global efforts to combine Integrated Gasification Combined Cycle power generation with Carbon Capture and Storage to produce low-emission, base load electricity. The company has received approval to develop the world's first commercial-scale IGCC with CCS power station in Queensland. The 530MW plant is expected to be operational in late 2015. 90% of the carbon produced will be captured and stored in the Northern Denison Trough where drilling is already underway to identify suitable reservoirs.

4.3 Coal Fired Generation

Coal fired power stations produce approximately 1 tonne of CO₂ per megawatt-hour, twice the emissions of gas, 6 times that of solar, 40 times that of wind and 200 times the amount from hydro-electric schemes. Victoria’s Hazelwood power station has been termed “the developed world’s most greenhouse-polluting power plant” because of its dependence on brown coal, although there are plans to capture 18,000 tonnes of CO₂ per annum from one of its 200 MW units in the future. 14 Greenpeace activists broke into the station in May 2009 and chained themselves to a coal digger before being removed by police.

The Australian Government’s \$400 million Greenhouse Gas Abatement Program invested \$145 million to reduce emissions by 27 million tonnes between 2008 and 2012, including \$5 million given to coal-fired stations to refine thermal efficiency, \$15.5 million for pre-drying brown coal and a \$58.8 million fossil fuel subsidy for methane capture.

Australia has one of the widest ranges of “Green Power” products in the world, but although these innovative programmes are attracting international attention, their additional cost to consumers means they are only taken up by a small fraction of households.

“The world’s energy system is at a crossroads. Current global trends in energy supply and consumption are patently unsustainable - environmentally, economically, socially. But that can - and must - be altered; there’s still time to change the road we’re on. It is not an exaggeration to claim that the future of human prosperity depends on how successfully we tackle the two

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central energy challenges facing us today: securing the supply of reliable and affordable energy; and effecting a rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply. What is needed is nothing short of an energy revolution” (International Energy Agency World, Energy Outlook 2008).

4.4 Carbon Capture and Geological Storage

The Federal Government has committed \$100 million to found a clean coal and carbon sequestration research institute to forge Australian leadership in this emerging field. Such technology will not be commercially viable in the short term, but the Government believes its development to be vital, given Australia's reliance on coal fuelled generation.

Carbon capture and storage aims to reduce emissions by capturing CO₂ from power plants and storing it securely underground instead of releasing it into the atmosphere. It can also increase yields from declining oil wells and store CO₂ produced from natural gas fields. No Australian power stations are currently equipped with this capability, and even if it should prove feasible, the extra costs of up to 40% per kwh, mean its deployment would rely on heavy carbon levies or stringent new emission regulations. Carbon pricing of at least \$30 per tonne would be required to make it viable, given the state of current ECBM and EOR technology, but if such pricing schemes are adopted by major governments, such schemes will become increasingly popular and attract further investment to reduce their cost.

Despite the long lead times in the design and building of new capacity, the huge scale of the electricity industry makes radical change easier, rather than harder, to implement. A small number of large firms, accustomed to tight regulation, run a limited number of stations, and if carbon capture technology could be improved and installed, the effects on consumers, beyond inevitably higher prices, are minimal. Compliance would also be simple to monitor. The opportunities for Australian firms which can develop such techniques are breathtaking, particularly in India and China, if global emission targets are to be met.

Although there are no commercial carbon capture schemes in Australia, demonstration operations underway include the Otway Project in Western Victoria, which has already stored 50,000 tonnes of CO₂ in a depleted natural gas reservoir 2000 metres below the surface with capacity for 50,000 more.

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This was Australia's first successful geosequestration and the largest research project of its kind. It is hoped that lessons learned from its innovative and comprehensive monitoring system will be adapted for future projects around the world. Unfortunately, plans for carbon sequestration from the proposed BP Kwinana coal to gas plant near Perth have been abandoned due to geological faults. Smaller demonstrations of various kinds are underway in the Latrobe Valley Post Combustion Capture Project and the CO₂ CRC/HRL Mulgrave Capture scheme, while CO₂CRC has commissioned three CO₂ capture research rigs at HRL's gasifier research facility at Mulgrave in Melbourne.

Although the physical principles behind carbon capture technology are clear, the engineering is still under development for commercial deployment with flue gas separation, oxy-fuel combustion and synthetic gas capture techniques all under examination.

CASE STUDY

Indigo Technologies provides sustainable air emissions solutions for clean coal combustion and industrial processes. It has successfully commissioned thirteen installations of its Fine Particle Control System in eight coal-fired power stations in the USA, Australia and China. Its Multiple Air Pollutant Control System will be the first commercial system to abate sulphur, nitrous oxide and mercury emissions in the same unit.

Flue Gas Separation is used at over a dozen facilities abroad, with the captured CO₂ used to produce dry ice, soft drinks and foam to subsidise its costs. Flue gas is bubbled through an absorbent material, which is then processed by a steam unit to remove the captured gas. This is then condensed to produce water and nearly pure carbon dioxide. The heating and cooling of the solvent and pumping of the gas all require energy, but the development of new membranes may cut these still prohibitive capital and energy costs.

Oxy-Fuel Combustion burns the coal in pure oxygen, rather than ordinary air, to produce flue gas composed almost entirely of CO₂ and water, which can be easily condensed. The machinery focuses on processing ordinary air pre-combustion, rather than flue gas post combustion. The nitrogen and trace amounts of argon and other inert gas separated at this stage can all be used in other industrial processes. This technique is still highly expensive and energy intensive, although Swedish energy firm Vattenfall has integrated it into a pioneering power station in Schwarze Pumpe, Germany.

Synthetic Gas Capture involves processing the coal before combustion, rather than the air or resulting flue gas. 'Gasifying' the coal produces a synthetic gas comprised of carbon monoxide and hydrogen which, when combined with water, produces CO₂ and additional hydrogen which can be used for fuel cells. There is currently no viable technology to produce base load electricity from pure hydrogen, but demand for the highly potent gas for transport and spot generation is bound to increase.

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Once captured, by whatever method, the carbon will ideally be transported to its storage facility by pipeline, rather than rail or road. Carbon can be stored in a variety of secure and capacious sites, although the management of such dumps is still in its infancy. It is theoretically feasible to pump CO₂ into the oceans at depths below 3,000 metres where the pressure will condense it to a liquid which will sink to form lakes on the seafloor. Releasing it at higher depths would see the gas suffuse into the water and contribute to the acidification of the oceans.

Carbon can also be secured in moribund coal seams. The CO₂ is readily absorbed by coal which then expels naturally occurring methane which can be captured for combustion. Such **Enhanced Coal Bed Methane Recovery** has potential in the United States, Europe, Russia, Indonesia and China and could produce over 7 billion tonnes of useable methane while sequestering 3.5 billion tonnes of CO₂.

Enhanced Oil Recovery boosts the productivity of oil fields while sequestering waste carbon dioxide. The gas is pumped into wells under pressure where it expands and forces previously inaccessible oil to the surface. The injected CO₂ also increases the viscosity of the oil. Such techniques can boost the productivity of a field by between a third and two thirds and is an established practice in the USA when it produces over a quarter of a million extra barrels of oil a day.

Deep saline aquifers are unsuitable sources of drinking water, but offer potential for carbon storage. If injected below 800 metres, pressure ensures the CO₂ will remain in liquid form before it slowly dissolves into the brine or reacts with the rock to form solid compounds. Some CO₂ will inevitably seep upwards, but can be prevented from reaching the surface by using aquifers with impermeable rock caps. Such a facility is currently run 250 km off the coast of Norway, storing 1 million tonnes of CO₂ from the Statoil Sleipner West gas field every year.

Commercial carbon capture and storage from coal fired power stations remains a distant hope, rather than an immediate reality. While carbon capture may be added to new power stations, it may prove impossible or impractical to 'retrofit' existing stations and the energy required may consume up to 30% more coal per kilowatt. Transport of CO₂ waste to underground storage facilities may prove impractical, given any large distances between the two, and leakage from underground or undersea reservoirs would be potentially catastrophic. In August 1986, a sudden release of volcanic CO₂ from Lake Nyos in Cameroon killed over 1700 people.

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Globally, there is a shortage of suitable and accessible storage sites compared to the enormous amounts of carbon which would need sequestering. Vaclav Smil, of the University of Manitoba in Canada, calculates that a transport infrastructure twice that of the world's oil production would be required to capture, transport and store even a quarter of the CO₂ emitted in 2005 by the power industry. Even if such an infrastructure were possible or financially viable, this would take decades to achieve. Australia's power stations in the Hunter Valley lack suitable, accessible storage while denuded oil fields in the Bass Strait are several hundred kilometres from the power stations in the Latrobe Valley and would require further expensive off shore development. The most geologically advantageous sites, in the North West Shelf, are thousands of kilometres from major emissions sources. Although the commercial potential for better techniques is clear, there is no prospect of such technology making immediate or significant cuts in Australia's, or global, carbon emissions.

Although Australia relies on colossal open cast mines, the potential for **coal gasification** in its seams underground shows promise where the geology allows. This technique avoids some of the expense of deep mining whilst generating a fuel with a lower emissions profile and the potential for carbon capture and storage. The ratio of inferred to proven mineable coal resources worldwide is about 6:1 and the potential increase in recoverable resources using the technique is approaches 7,000 Tcf. There are also large deposits of coal seam methane in black coal deposits in Queensland and NSW.

4.5 Oil

Crude oil production began in the mid 1960s with developments in Moonie in Queensland and Barrow in Western Australia, before the giant Gippsland Basin came on stream in the 1970s and offshore production began to grow in the 1980s. Although not popularly considered a major oil supplier, Australian fields yielded 600,000 barrels a day in 2008, making the country the world's 28th largest producer. Production is expected to slowly decline in the future, however, its proven crude oil reserves of 1,500,000,000 commercially recoverable barrels from known reservoirs may increase in the light of further exploration, particularly in the Carnarvon Basin. An average of 337,400 barrels per day were exported in 2008, while Australia used almost a million barrels a day as the world's 19th largest oil consumer.

For all the discussion of alternative fuel sources, oil derivatives will continue to power the overwhelming majority of the world's cars, lorries and aircraft for the foreseeable future. Australia's productive capacity would see it well placed to survive any future oil shocks with its reserves forecast to last at

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least 90 years at current rates of consumption. Looking to the long term, oil companies are becoming major investors in alternative energy sources and many major companies have attempted to reposition themselves as suppliers of heat, light and power services, rather than petroleum products. British Petroleum rebranded itself as 'Beyond Petroleum', adopting the sun as its new logo. BP's internal energy efficiency initiative has been its most profitable project over the past decade, generating savings of \$400 million US from investments of just a quarter of that sum. If the 'peak oil' hypothesis precipitates shortages in the future, Australia's known oil shale resources of almost 60 billion tonnes could produce 4,531 million tonnes of shale oil. 4 million tonnes were mined between 1862 and 1952 in Eastern Queensland, where reserves are easiest to exploit, before Government withdrew support, while a demonstration plant at the Stuart Deposit near Gladstone processed over 1.5 million barrels between 2000 and 2004. In 2008 a joint venture between MEC Resources and Bounty Oil was announced to investigate offshore drilling between the Central Coast and Newcastle.

CASE STUDY

Origin Energy was the first Australian retailer to offer customers the opportunity to offset their greenhouse gas emissions from the consumption of natural gas with "GreenEarth Gas" for around an extra dollar a week.

4.6 Natural and Liquefied Natural Gas

Natural gas production has increased steadily since the end of the 1960s, initially from the Surat, Gippsland and then Cooper basins. Natural gas consumption now approaches a fifth of primary energy needs. Australia's natural gas reserves approach 4,000 billion cubic metres (bcm), of which 20% are considered commercially proven with production centred in the Carnarvon and Browse basins in Western Australia, the Bonaparte basin in the Northern Territory, the Gippsland and Otway basins in Victoria and the Cooper-Eromanga basin in South Australia and Queensland. In 2003-2004, Australia produced 33.2 bcm of natural gas, of which 62% was produced in Western Australia, mostly from the North West Shelf, and new fields off the coast of Western Australia are continuing to offer an increase in supply. The development of carbon capture technology for gas fired power stations would be another large step towards cut Australian emissions.

Australia exported 7.9 Mt (10.7 bcm) of liquefied natural gas in 2004, 6% of the world total, largely from the Northwest Shelf LNG project. Exports are expected to rise towards 17 billion tonnes as the fifth train of the North West Shelf increases capacity and the value of Australia's exports is forecast to top \$11 billion in 2012/13. Production will continue to expand, despite the increasing capital costs of exploiting more remote offshore fields. An onshore programme near Gladstone in Queensland will offer a new capacity with reduced costs of extraction and transportation.

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4.7 Nuclear Power

The most dramatic move to slash greenhouse emissions would be to phase out coal fired electricity generation for nuclear power, however, Australia has long rejected the nuclear option despite its huge uranium reserves. The pro-nuclear findings of the Switkowski inquiry did encourage the Howard Government to consider a change, and initial studies were undertaken towards the building of a plant in Jervis Bay, but the Rudd Government has ruled out such a move, and Queensland and Tasmania have enacted state laws to prohibit nuclear development. However, if climate change proves even more damaging than already predicted, a change of policy is not impossible and technology such as the Integral Fast Reactor, developed in the United States between 1974 and 1994, removes the main objection to standard nuclear plants by reusing nuclear waste as fuel. Such 'fourth generation' plants may, in the absence of any realistic prospect of fusion power, be the only hope of replacing coal fire generation in the long term.

Russia, China and India are currently building fast reactors with France and Japan planning prototypes. Climate scientist Barry Brook is one Australian who is persuaded of their necessity, but public opinion remains opposed to their adoption, despite Australia's coal mines releasing more radioactivity than a modern nuclear plant.

4.8 Renewable and Alternative Energy

Australia has a plethora of renewable energy sources, of which only a tiny fraction are currently being tapped. Australia produced 9,500 TWh from renewables in 2006, less than 4% of its annual power consumption. The current Australian Government has a Mandatory Renewable Energy Target to increase this share to 8% by 2020, although doubts persist about targets after this date. Mass deployment of renewable technologies would substantially mitigate Australia's greenhouse gas emissions and, although significant technical and financial problems remain, the answer to the emissions crisis may lie not in making dirty energy expensive, but in helping clean energy become cheap.

When oil briefly touched \$150 a barrel and climate change dominated the headlines, the drive towards renewable energy appeared unstoppable. However, the financial crisis of 2008 and a dizzying collapse in oil prices saw stocks in green energy companies tumble, with the American WilderHill Clean Energy Index collapsing by 70% in 2008, compared to an overall fall of 38.5% in the S&P 500.

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CASE STUDY

AGL Green Balance electricity is certified “Greenhouse Friendly” by the Australian Government. Consumers pay a small extra charge to counterbalance fossil fuel emissions by eliminating or reducing emissions at factories or landfill rubbish sites and purchasing carbon offsets.

Despite this temporary setback, the long-term outlook for green energy remains bright, given that the International Energy Agency still predicts continued long-term growth in worldwide energy demand. It foresees a 45% increase in world energy consumption by 2030 and, even in the unlikely event of a global carbon price of \$90 being established, demand will still grow at 1.2%.

Although global coal reserves are still enormous, the marginal cost of new oil production is rising over time as more easily accessible wells are exhausted and new deep sea, shale or arctic sites are explored. Despite many false dawns over the past 40 years, green energy technologies are improving their efficiency and economic viability and, as industry volumes grow, economies of scale and further development will only reduce costs while carbon capture schemes may greatly increase the price of coal fired power. Electricity prices are still rising, despite the economic slowdown, and as the costs of traditional and renewable electricity converge, “grid parity” may be achieved. The political instability or outright hostility of several major oil producers further encourages domestic energy production for reasons of national security. It is possible that utilities and investors may begin to baulk at investment in fossil sources and back renewable as a safer long-term option.

In its budget of May 2009, the Federal Government announced its intention to invest \$4.5 billion in renewable energy production and carbon reduction technology, including \$1.6 billion over six years on major solar projects and \$2 billion for industrial carbon capture and storage schemes.

4.8.1 Hydro electric

Hydroelectricity accounts for 6.5-7% of Australian electricity generation with the massive Snowy Mountains Scheme accounting for the lion's share. This one project generates around 4500 gigawatt hours of renewable energy each year, three quarters of all renewable energy on the grid. Given Australia's lack of mountains, rainfall and major river systems, and the huge costs and environmental issues of such schemes, there is little scope for major expansion.

4.8.2 Wind

Australia's wind generation capacity stood at nearly 1.5 gigawatts in June 2009 and produces 1% of the nation's needs, largely in South Australia. There is potential to increase output to 10 GW by 2016. Wind farms can be combined with pastoral and agricultural land use and turbines are up to 45% efficient, out of a maximum theoretical level of 59%, while even modern coal fired stations convert only 35% of the fuel's energy into electricity.

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CASE STUDY

Established in 2001, Melbourne's **Wind Power** develops wind farms across Australia. It manages, runs or plans stations at Stockyard Hill (484 MW) near Ballarat, Wonthaggi (12 MW) in Gippsland, Lexton (38 MW), Bald Hills (104 MW) and Waubra (192 MW).

Although not thought of as a windy country, Australia's southern coastline lies in the "roaring forties" with average wind speeds approaching 10 km/h, and the southwest of Western Australia, southern South Australia, western Victoria, northern Tasmania and higher areas of New South Wales and Queensland all have suitable sites for wind turbines. Firms such as Suzlon, TrustPower, Wind Prospect and Windlab Systems are all well placed to benefit from an expansion of wind generation. In August 2009, The Age reported that the first of three major wind farms had been given the go ahead to help power new energy hungry desalination plants.

A more speculative idea is the use of huge kites to generate power from the jet stream which holds over a hundred times more kinetic energy than is generated by man. Electricity produced by spinning rotors on kite turbines tethered at 32,000 feet would be transmitted down their cables to the distribution grid. Studies show that outputs of 10 kilowatts per square meter would be possible, 10 times the output available on the ground. Southern Australia has been identified as one of the areas most suitable for such machines, but practical demonstrations of the concept have yet to be undertaken.

One caveat is that major investments in wind power by Denmark and Germany have failed to reduce overall greenhouse emissions due to emissions trading. Around 15% of Germany's energy is derived from renewable sources, with the €35 billion industry supporting up to a quarter of a million jobs, but the emissions saved have simply allowed Eastern European countries to pollute more through the purchase of EU carbon credits. Cuts in German coal fired electricity production led to a fall in the price of CO₂ emission certificates, which were then sold at nominal sums to heavily polluting Polish and Slovenian power stations, which therefore had no incentives to reduce their rates of emission.

4.8.3 Solar

Solar power could theoretically meet all of sunny Australia's heat and electricity needs. Less than 1% of power is generated by the sun at the moment, due to the high cost of solar panels among other factors, but a variety of innovative solutions are being developed which could be scaled up to meet potentially unlimited world market demand. More widespread integration of photovoltaics into single buildings for inhouse generation is being investigated, while a 154 MW Solar Systems photovoltaic station is planned in Victoria for 2013 at a cost of \$420 million. This plant will produce 270,000 MWh per annum, enough to meet the needs of over 45,000 homes and saving approximately 400,000 tonnes of CO₂ per year.

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Seville's PS10 solar power tower plant generates 11 megawatts from 624 heliostats. Nearby PS20, currently under construction, will be twice as powerful

The Australian National University has worked on dish concentrator systems since the early 1970s, and projects at the Universities of Sydney and New South Wales led to the creation of Solar Heat and Power Pty Ltd (now Ausra), which is currently building a major project at Liddell Power station in the Hunter Valley. CSIRO's Division of Energy Technology has also opened a 500 kilowatt solar energy centre in Newcastle featuring a prototype trough concentrator array developed with the ANU.

Concentrated solar power stations employ arrays of mirrors to focus large amounts of sunlight on a small area to heat water to drive steam turbines or Stirling engines and have the potential to provide significant amounts of power. It has been estimated that plants covering just 1% of the world's deserts could satisfy global energy needs, while an area of 140 square kilometres would supply the whole of Europe. One such plant operates successfully in Spain and more are planned in Algeria, Morocco and the United Arab Emirates. The potential for such plants in Australia is obvious, especially if huge projects such as the proposed "Desertec" in the Sahara prove successful.

CASE STUDY

Atlantis Energy Systems, Inc. is the world's first manufacturer of Building Integrated Photovoltaics. A typical roof installation of 28 square meters of 'Sunslate' roofing tiles can generate between 60% and 80% of a household's power needs. 28 of its larger 'Megaslates', suitable for commercial buildings, can generate over 4.2 kW at peak.

Cloncurry in Queensland will host a new \$31 million Ergon Energy solar thermal power station delivering around 30 million kilowatt hours of electricity a year, enough to power the whole town, while in August 2008 Worley Parsons, an Australian engineering firm, announced plans to build Australia's biggest solar plant by 2012. Backed by nine Australian companies, including the mining giants BHP Billiton and Rio Tinto, the company is studying possible sites for the \$1 billion scheme.

Australian research into improved photovoltaic technology is bearing fruit, with the SLIVER cell developed at the Australian National University Centre for Sustainable Energy Systems using a tenth of the expensive silicon required by conventional designs. Another team of researchers at the University of New South Wales set a new record for solar cell efficiency with a multi-cell combination that converts 43% of the sun's energy. Although the cell uses expensive superconductors and is not commercially viable, it demonstrates that Australian universities and companies have the ability to lead the world if the necessary funding is made available. CSIRO's Future Manufacturing Flagship is exploring ways to print plastic solar cells reel-to-reel with the help of banknote printing company Secrecy International. This would not only enable rooftops or irregular objects to be covered in large sheets of cells, but revolutionise the industry by facilitating quick, cheap, bulk production.

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The \$75 million Solar Cities programme seeks to demonstrate how solar power, smart meters, energy conservation and new approaches to electricity pricing can combine to provide a sustainable energy future in urban areas. It is a partnership between all levels of Government, the private sector and the local community with Adelaide, Townsville, Blacktown and Alice Springs the first four communities involved. Australia has produced domestic solar water heaters since the 1950s, although only 5% of homes have them installed.

To put the technical sophistication of Australia's solar power plans into perspective, however, Japan is investigating the concept of placing a \$21 billion, 4 km², 1 gigawatt solar-powered generator in orbit by 2030.

CASE STUDY

Protean Power Ltd is an Australian company which has developed a unique wave buoy to generate power by exploiting the sea's relative movement between the static ocean floor and the surface through an igneous tension mooring system. This extracts energy in all conditions, no matter how calm, to produce electricity which is then cabled ashore. The technology is simple to deploy, scalable and economically competitive with other sources.

4.8.4 Wave and Tidal

The kinetic energy of waves can be harnessed by the movement of buoys driving a turbine, while tides can drive underwater turbines. Tidal power has the advantage of being reliable and predictable, and with as much as a thousand tonnes of water passing through a turbine's blades every second, a small device can create a relatively large amount of electricity. Australia lacks the strong tides which make such underwater windmills so promising in Britain and Canada, but it is theoretically possible to use similar techniques to tap deep ocean currents.

A wave farm already operates near Fremantle in Western Australia and the Australian Government has provided more than \$600,000 in research funding for technology developed by Carnegie in Perth. Their technique uses wave energy to pressurise sea water, which is then piped ashore to drive turbines and produce desalinated water. The company plans to finish a 50 MW demonstration project within four years. Oceanlinx is trialling a wave energy system at Port Kembla, while BioPower Systems is developing its bioWAVE system off Northern Tasmania. This project involves buoyant blades, anchored to the seabed, which are moved in a swimming motion by waves.

Other ideas contemplate generating electricity from the difference in salinity between rivers and the ocean or by exploiting the temperature differential between the sun-warmed surface and frigid regions below.

4.8.5 Bio-Energy

Biomass power plants burn vegetative by-products, and there is great scope to extend their use in Australia, notably by combusting sugar cane waste to power sugar production. Biomass can be co-fired with coal in existing power stations without expensive modifications and helps to reduce sulphur and nitrogen oxide pollution.

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CASE STUDIES

Ignite Energy

Resources seeks to use its proprietary continuous flow super critical water reactor to process coal and plant biomass into oil and a range of other products. When heated or pressurised to its 'critical point' IEG believe that water can depolymerise organic polymers in a fraction of the time of traditional methods while saving 60% of the usual CO₂ emissions. The company target the 18 billion tonnes of brown coal in Gippsland and Australia's large potential for biomass production as suitable for conversion. Vegetable oil has been converted into biodiesel by Saka and other experimenters using supercritical methanol without a catalyst.

Established in 2001, **BP Global Choice** helps customers neutralise fuel emissions. It has offset over 1.8 million tonnes of CO₂-e to date, the equivalent of taking over 350,000 cars off the road for a year. The programme allows customers to invest in a range of abatement projects including energy switching and methane destruction.

A study for the National Renewable Energy Laboratory found that co-firing a 15% mix of biomass with coal also reduces life time CO₂ emissions by 18%. It is possible that "carbon negative" power plants fired by biomass and coal could be designed to reduce net atmospheric carbon dioxide. Biomass gasification can be used in combined cycle generation and reach efficiencies of almost 60%, compared to 40% in supercritical coal fired stations.

First generation Biofuels, recently seen as the saviour of the transport industry, have become controversial as the implications of forest destruction or the substitution of food crops for their production became clear. Ethanol can be produced in Australia from sugarcane or grains, and there are three commercial producers on the east coast, with a 10% blend on sale in New South Wales and Queensland service stations.

Biodiesel produced from vegetable or animal fats, notably recycled cooking oil, is another alternative, given the nation's heavy reliance on road transport and the growing popularity of fuel-efficient diesel cars. Biodiesel can be used in cars without modification, usually mixed with conventional diesel, and generates less carbon dioxide and no sulphur dioxide while improving engine lubrication. Biobutanol boasts an energy concentration almost as high as petrol and can be transported using the same distribution infrastructure.

Second generation bio fuels show promise and would offer rich commercial prospects for firms which perfected their production. The conversion of agricultural waste such as rice straw or corn stover, fast growing and drought resistant grasses grown on marginal land or algae offer more energy efficient fuel with much lower 'life cycle' emissions of CO₂ than corn based ethanol. German yoghurt firm Muller is seeking to turn waste products into valuable materials by manufacturing bioethanol from dairy waste products.

60 billion litres of fuel are consumed every year by the world's airlines and biofuel alternatives are at a premium. Biofuel mixes have already powered passenger jets in test flights run by Virgin Atlantic and Japan Airlines, while results from an Air New Zealand test flight proved that jet fuel refined from jatropha oil can cut greenhouse gas emissions by at least 60% compared to conventional kerosene. Jet fuel based on the European flower Camelina can reduce emissions by up to 80%.

Algae can express 60% of its body weight as oil under the right conditions and can thrive in salt or wastewater. Selective breeding or genetic modification to increase yields and ease processing are promising lines of endeavour and known problems of fuel density and viscosity at high altitude temperatures are being tackled at centres in Italy and the United States.

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CASE STUDIES

In its third year of operation, **Australian Renewable Fuels** produces biodiesel at two plants in Adelaide and Picton, Western Australia. Converting used cooking oil and tallow, each plant produces 44.5 million litres of biodiesel a year with by-products including 4,000 tonnes of raw glycerine and 1,200 tonnes of sulphate of potash.

Australian airlines **Jetstar**, **Qantas** and **Virgin Blue** offer passengers the opportunity to offset the greenhouse gas emissions of their domestic and international flights.

Pure bio fuels are currently impractical as kerosine's hydrocarbon rings are required to maintain engine seals. The International Air Transport Association has set a goal of "carbon neutral growth" by 2020 through greater fuel efficiency and the use of such bio fuels.

At the furthest edge of research, the synthetic creation of 'designer' bacteria to manufacture hydrogen and bio fuels and absorb CO₂ and other greenhouse gases is being pursued. American Craig Venter, who worked on deciphering the human genome, has applied for patents to make new bacteria by introducing oligonucleotides to laboratory cultures. Bacteria routinely swap DNA and, in theory, by incorporating functionalised synthetic DNA, the bacterium could be manipulated to produce plastics, drugs or fuels such as ethanol or hydrogen.

4.8.6 Geothermal

Geothermal power, exploiting the heat generated by isotope decay in the earth's mantle, is a renewable, inexhaustible and zero-emission power solution. Unlike most renewable sources, it can provide base load power 24 hours a day, 365 days a year. A geothermal plant is also unobtrusive, unlike wind turbines, and has no environmental implications, unlike a tidal barrage.

Although Australia is the oldest and most geological stable landmass on earth, it has a surprisingly large potential for geothermal energy production, particularly in the deep granite systems of Central Australia and South Australia. It is estimated such 'hot rocks' could meet 6.8% of Australia's base load energy needs by 2030. The 2008 Federal Budget allocated \$50m to assist with 'proof-of-concept' projects through the Renewable Energy Fund.

Enhanced geothermal systems or "hot dry rock geothermals" use bore holes drilled several kilometres into the crust, through which water is pumped at high pressure. This fractures the rock, opening up large areas to heat the penetrating water. Under pressure, the superheated liquid can reach temperatures of 200 degrees, and the steam is then tapped through other bore holes to drive turbines or heat homes.

A geothermal power plant is already generating 80 kW at Birdsville in southwest Queensland and 12 companies have applied to drill in 116 areas in South Australia and plan to invest \$A524 million over the next six years. Ten projects are expected to achieve heat flows by 2010 with at least three demonstration projects producing power by 2012. The West Australian Government is also looking to establish geothermal energy as a long-term, alternative energy source, with a range of companies taking up a permit to conduct exploratory drilling.

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4.8.7 Home and Commercial Generation and Storage

More than half the energy released by the incineration of coal for electricity is lost through the cooling towers, while 5% is lost in transmission down power lines. An alternative approach is to decentralise generation to homes and commercial properties by using fuel cells – essentially batteries powered by a fuel source such as natural gas, ethanol or captured methane. The waste heat could then be used for hot water and heating and save up to 2.8 tonnes of CO₂ per year per home. The CO₂ produced by combustion is mixed only with water, making its separation and capture relatively straightforward. Domestic solid-oxide fuel cells the size of washing machines have already been developed, and a 2 kilowatt system can be produced for under \$6,000, a price which would tumble with mass production. In addition, home-generated electricity, be it by wind, solar, biomass or other means, could not only supply a household's power needs, but be fed back into the electricity grid and rewarded with 'feed in tariffs'.

The obvious inability of wind or solar energy to guarantee base load generation has been one of many stumbling blocks against their adoption. Electricity is easy to distribute, but difficult to store, with Australia using most of its hydro-electric capability to pump water off-peak to cover peak load. Electricity demand can fluctuate by over 300%, depending on the time of day and year, and high demand may bear no relation to green power production. The use of 'flow' batteries to reconcile supply and demand, already common in Japanese industrial plants, is a possibility, as are large lithium batteries or even the batteries on electrical vehicles, if they become commonplace.

Commercial and domestic hot water immersion heaters store energy and can redistribute it to the national grid using 'ripple controls' through the mains electrical system. New Zealand has used this method to reduce peak demand by 13%; it is being introduced in South Africa to avoid damaging power cuts and, in Florida 700,000 customers of one company receive a monthly rebate for handing over control of their hot water heaters for this purpose, saving the construction of a 1GW power station. Balancing the whole grid is far more complicated than occasionally reducing peak demand, however, and ripple control, which cannot receive information from hot water tanks, does not allow operators to know how much flexible capacity is available or how many units to control. As 'smart meters' for power become more common, it is possible that computationally enabled immersion heaters and other electrical appliances could be linked via the internet and integrated into a 'smart' electricity grid which would balance demand and supply to maximise generating efficiency.

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Many companies produce their own power onsite, and the use of low emission energy systems employing solar power or natural gas can make excellent commercial sense. UK cosmetics firm Body Shop bought a 25% share in a wind power firm to provide renewable energy for its operations, while major American companies such as 3M, DuPont, General Motors, IBM, Johnson & Johnson and Staples use onsite renewable energy plants. Verizon used a combination of energy efficient Hypalon roofs, natural gas micro turbines and fuel cells to reduce its costs by over \$600,000 a year.

CASE STUDY

Carbon Conscious Ltd

is an Australian company offering carbon credits through 'carbon farming' by planting Mallee Eucalypt trees in Australia's wheat belt. These drought resistant trees are deep rooted and tap water supplies below the roots of crops and pasture, helping to fight dry land salinity. Trees lift crop yields and lambing percentages while creating wildlife corridors and improving the aesthetics and amenity of the farm.

4.9 Primary, Secondary and Tertiary Industries

4.9.1 Forestry

Around a quarter of Australia's greenhouse emissions result from livestock husbandry, crop production, land clearing and forestry operations, while Australia's remaining native forests and plantations provide a significant greenhouse sink.

Globally, the destruction of forest and the burning and draining of peat lands release nearly 8 gigatonns of carbon each year, about 16% of global emissions. 332 million hectares of forest, an area the size of India, were destroyed between 1980 and 2005, largely in Brazil, Indonesia and Africa. Australia has a long history of land clearing, a devastation of the natural environment which has only recently slowed. Reduced land clearing, the protection of old growth forests, afforestation of marginal croplands, pasturelands and degraded areas and improved forest management practices are therefore important steps towards restoring the planet's carbon balance both at home and abroad. Malcolm Turnbull has emphasised the importance of forestry in the Opposition's approach, while the impact of land clearing is still omitted from some current government figures. Companies offering reforestation services will be well placed to take advantage of inevitable replanting schemes. The end of deforestation and the reforestation of denuded land are perhaps the most cost effective routes to achieving large savings in carbon emissions in the short term.

Firms can benefit from buying materials from sustainable sources in terms of public relations and by ensuring security of supply. The trademark offered by the Forestry Stewardship Council is widely recognised, for example, with the organisation promoting responsible forest management in 90 million hectares of forest across 70 countries. Thousands of products sold worldwide are manufactured using FSC certified wood and appeal particularly to the 'green' consumer.

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CASE STUDY

The United Nations Environment Programme's "Plant for the Planet: Billion Tree Campaign" encourages individuals, communities, businesses, civil society organizations and governments to pledge to plant at least one billion trees worldwide each year. In a call for further individual and collective action, UNEP has set a new goal of planting 7 billion trees by the end of 2009. The campaign advocates the planting of indigenous trees appropriate to the local environment and to date 6,529,615,422 trees have been pledged and 4,758,729,659 have been planted.



The wholesale draining and destruction of wetlands around the world has been disastrous for biodiversity and carbon emissions. Up to 60 tonnes of CO₂ are stored in an acre of peat, and the restoration of former bogs and marshes would be another simple and cost effective method of sequestering carbon.

4.9.2 Agriculture

The natural carbon cycle sees plants capture CO₂ through photosynthesis and sequester it in the soil. The burning of fossil coal releases plant captured carbon into the atmosphere more quickly than the earth's vegetation can reabsorb it. Increasing the carbon content of Australia's soil through improved agricultural practices could sequester colossal amounts of CO₂ and is one of the most practical and cost effective ways for a largely agricultural country such as Australia to play its part in the fight against climate change.

Australia's thin ancient soils have lost around 75% of their pre-European settlement carbon, a total of between 150 billion and 200 billion tons, due to unsuitable farming practices. Land used for dryland cropping and grazing typically contains just 1.5% carbon today, compared to the 5% of healthy soil. Australia has around 500 million hectares of agricultural and pastoral land, and a 1% increase in soil carbon in 10% of this area could remove a decade of Australia's current emissions.

Improved grassland management can be achieved through changes in grazing patterns, fire control and species introduction. Arable land degraded by excessive clearance, disturbance and erosion can be restored through revegetation, reduced tillage and water conservation combined with crop rotation, less intensive cropping and reduced residue removal. Such measures would reap benefits in long-term productivity and water retention beyond their contribution to limiting climate change. A shift to the farming of native species for food, particularly kangaroos whose meat is low in fat and high in protein, would further assist preservation of the soil.

On natural grasslands, such as the American prairies or the Serengeti, large herds of grazing animals intensively crop areas before moving on, allowing the grasses to recover and lock carbon into the soil. Most grassland today is cropped continually, halving its ability to fix carbon. A switch to natural grazing patterns might remove up to 100 tonnes of atmospheric CO₂ per hectare.

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CASE STUDY

As part of their wider business plan, **Ignite Energy Resources** propose a large scale commercial approach across agriculture to bio-sequester CO₂ as soil carbon, via crops and grasslands, and generate enough low cost soil carbon credits/offsets to mitigate the uncertainty of carbon pricing for 50 years. They calculate that one million hectares of farmland implementing natural sequence farming to rehydrate the soil, rotational grazing patterns and biological farming and fertilisation systems would produce around 15 million tonnes of soil carbon credits per annum. If linked to oil production from brown coal using their catalytic Hydrothermal Reactor Technology this would deliver power with zero net emissions. Furthermore Gippsland lignite (brown coal) is ideally suited for the large-scale manufacture/distribution of Biological Fertiliser based on the high humic/fulvic content of some of the deposits.

The introduction of “soil carbon credits” has been suggested as an incentive for farmers to change their farming practices. The Federal Government is not yet convinced of its practicality, but Malcolm Turnbull has emphasised the importance of soil carbon in the Coalition’s policy. Such a concept would need an effective accounting system to make it a tradeable commodity. Once the CSIRO has confirmed the effectiveness of soil carbon processes, its proponents hope farmers will amend their practices to increase farm productivity.

The August 2009 CSIRO report ‘Sustainable Agriculture’ – ‘An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use’ argued that Queensland could ‘attain’ a 77% reduction of its annual greenhouse gas emissions (140 Megatons of CO₂-e) through changes in rural land use and management. It estimates the potential in the state to be 293 Mt CO₂e/yr for the next forty to fifty years, until the soil approaches saturation.

Livestock emissions of methane rival those of road transport and deforestation. Dietary additives and feed supplements can reduce the problem and, although currently expensive, vaccines against the methanogenic bacteria responsible for enteric fermentation may be widely introduced. Better manure management would further cut methane pollution, with the collection of the gas for onsite electricity generation a possibility. A shift from meat production to drought resistant crops and bio fuels is possible in the medium term. Nitrous oxide pollution can be reduced by better crop burning and soil management practices.

On a more prosaic scale, the energy consumed by glasshouse crops can be reduced by computer controlled environmental systems while heat can be recovered with condensers, stored in buffer tanks and retained by thermal screens. The cooperation of companies in local heat and power schemes can also prove mutually beneficial. British tomato growers John Baarda Ltd use waste steam produced by fertiliser manufacturer Terra Nitrogen to heat its greenhouses while, in Holland, Shell sells carbon emissions to nearby horticultural businesses for their greenhouses. Shell also receives direct payments for the excess CO₂, tax breaks to cover the infrastructure costs and credits under the European trading scheme. Dairy farms, meanwhile, can employ heat recovery on milk vats, bio digesters and chemical substitutes for hot water washes to reduce their energy bills.

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Abandoned farmhouse in the Flinders Ranges

CASE STUDIES

Papyrus Australia converts banana trunks into raw paper or “Banana Ply Paper” with significant advantages over traditional pulped paper manufacturing. As well as the world’s most popular fruit, with over ten million hectares under cultivation, the trunk of the banana plant is a sustainable, renewable and abundant source of fibre. Traditional paper making consumes large amounts of water and energy to render soft wood into useful fibres while banana trunks do not require pulping and the water used onsite can be recycled for plantation irrigation. The technique turns a secondary waste product into a valuable product while saving energy and carbon emissions in the process.

Carbonscape, based in Marlborough, New Zealand, has developed a biochar manufacturing method using microwaves.

The profligate flows of water wasted through poor irrigation practices can be reduced by covered pipes, variable pump drives and better soil moisture management, however, ongoing water shortages will continue to shrink Australia’s rice industry, another major source of methane, except in the far north. A radical revitalisation of Australia’s agriculture would benefit the sector by improving the sustainability and productivity of farms already under pressure from drought. A mix of government incentives, changes in subsidy and education should be instrumental in achieving these aims.

Agriculture may also return to Australia’s densely populated urban areas. The construction of 30 story ‘vertical farms’ has been advocated by Columbia University microbiologist, Dickson Despommier. Their greenhouses and fish farms would produce food, recycle water and generate methane for electricity as well as save on transportation.

4.9.3 Biological Sequestration through BioChar

Biochar is a biological method of carbon capture and storage in which high carbon anaerobic charcoal, produced by the heating of crop and forestry waste or other biomass in a low oxygen kiln, is buried to create terra preta. The process releases more energy than it consumes as more hydrogen, methane and other combustible gases are released by the dissolution of the long hydrocarbon chains than are needed to heat up the kiln. The carbon in biochar is stable and, if mixed with poor-quality tropical soils, can significantly boost crop yields and reduce nitrous oxide and methane emissions. It can also improve the structure of the soil as the particles are covered with microscopic pores that can harbour useful fungi and bacteria which also extract more CO₂ from the air. The method has been promoted as a promising avenue of research by Malcolm Turnbull. Given that wood from virgin forest is not cut for the purpose, it has great potential as both a micro and macro method of reducing carbon concentrations while improving crop yields denuded by poor agricultural practice in the past. Unfortunately, the potential of bio-sequestration to draw down significant quantities of legacy atmospheric CO₂ is seen by the current Government as the ‘poor relation’ of geological sequestration of power station emissions.

4.9.4 Coal Mining

Australia is the world’s fourth largest producer of coal and Newcastle hosts the largest coal exporting terminal on the planet. The port was the target of hundreds of environmental protesters in March 2009, who staged peaceful blockades in an attempt to preventing coal ships from entering.

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Australia is the 4th largest coal producer in the world

Australia mined over 300 million tonnes of hard coal and 71 million tonnes of brown coal in 2005. Three quarters of Australia's coal production is exported, largely to South East Asia, with the remainder powering 80% of Australia's electricity supply. Coal is a major producer of greenhouse emissions, but despite the mandatory renewable energy target and the tabling of the Carbon Pollution Reduction Scheme, there is little likelihood of this production being curbed in the foreseeable future.

The mining of brown coal, or lignite, in Victoria is particularly controversial. It has a carbon content of 25-35% and can be up to two thirds water in weight, leading to highly inefficient combustion. Its ash content is also higher than black, bituminous coal. Victoria relies on the brown coal power plants in the Latrobe Valley and has at least 500 years of reserves at current rates of consumption. The Victorian Government is examining more environmentally friendly generating methods, such as oxy-fuel combustion or gasification, but their adoption in commercial plants remains a distant prospect. An expansion of unmodified brown coal fired generation would far outweigh any gains made so far in renewable sources or energy conservation.

In November 2006, Justice Nicola Pain, sitting in the New South Wales Land and Environment Court, set aside the Director-General's acceptance of the Environmental Assessment for the proposed Anvil Hill coal mine as it had failed to include a comprehensive greenhouse gas assessment, despite the fact that the coal would be exported and burned abroad. In June 2007, New South Wales Planning Minister Frank Sartor reversed the decision and approved the mine although 80 conditions were attached to its operation including the need for carbon offsets.

4.9.5 Cement

Cement production is responsible for 4% of global greenhouse gas emissions, with China producing half this figure alone. An average cement plant releases around one megaton of CO₂ per year, but this can be substantially reduced through improvements in fuel combustion and other processes.

It is possible to substitute clinker (the calcinated and mineralised limestone which comprises 95% of cement) with fly ash, granulated blast furnace slag or other mineral waste from the power or iron and steel industries. The use of alternative fuels, such as municipal waste or biomass, in clinker making kilns should be encouraged and carbon capture technology employed. There are also modest gains to be found in waste heat recovery systems.

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These measures would actually save money as the extensive replacement of clinker with industrial waste would reduce the need for expensive new clinker production capacity. Such substitution would depend the revision of cement production and building codes to focus on performance, rather than composition and the processing of ash or slag to the necessary granulation.

4.9.6 Aluminium

Australia is the world's 5th largest producer of aluminium, accounting for 7% of global production, and has some of the largest bauxite reserves in the world. Smelting aluminium from the alumina produced by refining bauxite produces significant emissions and the introduction of carbon pricing would force rapid change in the industry. In the United States, Alcoa cut their greenhouse emissions by a quarter through improving one key step in the process of production. Ironically, given the amount of bauxite in the earth's crust, the recycling of aluminium is the one case where it is already cost effective.

Australia's second largest smelter, the giant Tomago plant north of Sydney, was the target of environmental protestors in June 2009. The group 'Rising Tide' claimed that Australia's aluminium smelting was 250% more polluting than the global average due to Australia's reliance on coal fired power, and that the plant would get 90% of its pollution permits free through Government rebates as part of its stalled carbon reduction scheme.

4.9.7 The Building Industry

Buildings account for over 8 gigatons of CO₂ emissions per year, almost a fifth of the global figure, and comprise almost a third of discharges in developed countries. Direct emissions from their consumption of energy account for 8% of the global total, with indirect output responsible for a further 10%. A range of simple and proven techniques could, if systematically and universally implemented, greatly reduce this figure at comparatively low cost. Buildings stand for an average of 65 years in the developed world, and this long life cycle allows the extra costs of energy efficient infrastructure to be discounted over a lifetime of use.

Companies which factor environmental considerations into designs and alterations will have a significant selling point over less proactive companies. Perfectflow Technology Pty Limited, for instance, have designed a water saving shower head, cutting flows from up to 22 litres per minute to just 5.5. The use of such a shower could save almost 50,000 litres of water per person per year.

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The water efficiency rating of showerheads is currently capped at 3 stars. Water efficiency could be encouraged by adopting a similar scheme to that applying to taps and relating the star rating to the number of litres of water used per minute. Instead of all showerheads using 9 litres or less being awarded the same 3 star rating, the updating of the **WELS (Water Efficiency Labelling Scheme)** star rating with the award of four or five stars for showerheads offering between 9 and 7 and 7 and 5 litres would encourage their adoption.

Finer grained ratings would allow a more accurate calculation of usage and consequent greenhouse gas savings in various state based schemes such as the Victorian Energy Efficiency Target (VEET), Residential Energy Efficiency Scheme (REES) in South Australia and the NSW Energy Efficiency Scheme (EES) scheme in NSW. In addition, companies participating in such residential efficiency programs are likely to install more efficient products despite their slightly higher cost as they are able to offset that additional cost by attracting a higher rate of carbon certificates which can then be sold to energy companies.

The **NSW Energy Saving Scheme** has led the way with changing the deeming value for Showerheads operating at less than 6 Litres per minute. The prospect of reduced rainfall in Southern Australia will also underline the need for water conservation measures to be built into new developments and refurbishments, while the growing threat of bushfires will lead to planning regulations deterring the building of new homes in high risk areas.

CASE STUDY

Ecoflex converts waste tyres into building products that capitalise on the structural strength of reprocessed tyres to deliver a cost effective building block or containment device with unique engineering properties. The products have proven effective for a wide range of civil and commercial construction purposes from retaining walls to paving systems while cutting construction costs by between 15 and 25%.

The government is investing in schemes and providing rebates for energy efficient products to help the community adjust and reduce their energy consumption. Schemes like Green Loans help educate the householder to reduce their footprint and also provides interest free loans to invest in energy saving measures. In addition, Solar and Insulation rebates help residents afford to install the products and reduce their energy costs.

The incremental rise in sea levels will put developments on reclaimed or low lying land at risk, particularly in the high growth areas of coastal Queensland. Areas threatened by more intensive storms and flash flooding will also require more resilient building designs, not least to reduce insurance costs, which are likely to spiral in the event of large claims for weather induced damage. There is great scope for State governments to drive the process by instigating new housing and energy efficiency standards relevant to their local needs.

Passive cooling and heating measures could prove far more effective in reducing demand than more grandiose combined heat and power schemes.

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New buildings can be orientated more logically in regard to the sun, while better insulation, roofing, wall and floor materials can all play an important role. Retrofitting schemes to improve the insulation of existing buildings can reduce energy demands to heat or cool the interiors. Comprehensive insulation of roof and wall spaces, the weather sealing of doors and windows and the installation of heat recovery enabled ventilators can reduce average energy consumption per metre from 70 kWh to 25.

The replacement of a gas fired system with condensing heaters reduces energy consumption by almost a third, while the use of solar heaters can achieve savings of up to 85%. The replacement of electrical heaters with heat pumps can achieve savings of approximately 60%. Heat recovery systems integrated into ventilation machinery can slash energy bills for large public and commercial buildings which often waste large quantities of energy due to a lack of personal incentives to minimise its use. The replacement of traditional incandescent bulbs with more efficient compact fluorescents is already well advanced, with sales of the former banned in several countries including the UK. The development of better light emitting diodes, more than ten times more efficient than incandescent bulbs, would provide further savings. Consumer appliances are becoming more energy efficient, saving between 20 and 30% on devices not optimised for economy.



Surfer's Paradise in Queensland showing extent of recent coastal development

Niclas Svenningsen and Thierry Braine-Bonnaire considered the benefits of a 'whole system engineering' approach in 'The buildings challenge, entering the climate change agenda' in 2007. Viewing the entire building as a single system and retrofitting it to maximise efficiency produces a series of gains. An analysis of the refitting of a 20,000m² office tower in Chicago showed the fitting of efficient windows, lights and office equipment reduced the cooling load by 85%, allowing the replacement cooling system to be 75% smaller and \$200,000 US cheaper. This saving alone paid for all the other renovations and reduced the annual energy bill by 75%.

European construction firm Siemens offers performance contracts promising energy and financial savings when bidding to upgrade buildings, with any shortfall made up by the firm and profits shared by all. So far it has reported worldwide savings of nine million tonnes of CO₂ and one billion Euros. The use of natural landscaping and efficient materials, combined with energy reduction techniques and the encouragement of recycling, can help produce modern, attractive indoor environments that increase worker productivity and advertise the company's ethos in a literally concrete fashion.

More innovative ideas include the incorporation of "algae based photo bioreactors" into structures. These transparent tanks of algae remove CO₂ from the air by photosynthesis and can be periodically harvested for bio fuel.

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A chemical engineer at the Massachusetts Institute of Technology, Isaac Berzin, used algae in a pilot project to capture CO₂ produced by M.I.T.'s on site gas fired power plant and reduced CO₂ emissions by 82% on bright days and 50% in overcast conditions. A start up company, GreenFuel Technologies Corp, has been formed to develop the idea.



The pollution haze over Perth

A building firm offering 'homes for the future' should utilise the full range of Government assistance available to reduce upfront capital costs and advertise the long-term energy and environmental benefits of their dwellings. Such houses would have garages with heavy duty power cables for plug in cars, substantial insulation, glazing and shading to moderate extremes of natural temperatures and solar heating and hot water systems which might also generate electricity to be sold back to the national grid. Roofs and gardens would also capture rain and grey water for a variety of domestic uses. Such 'smart homes' would incorporate energy efficient air conditioning and automated monitoring systems to limit water use and turn off lights when residents vacated a room. All this technology already exists in piecemeal form, and firms which package it for environmentally concerned house buyers are likely to be able to sell at a premium.

CASE STUDY

In May 2009, **Sydney's Lord Mayor** announced the City would spend \$18 million over three years to halve the greenhouse emissions of its properties. It also aims to improve their energy efficiency by 28% by 2012 as part of the "Our Sustainable Sydney" plan which targets a 70% reduction by 2030.

The City of Sydney was the first Australian council to go "carbon neutral" and uses accredited GreenPower to offset its emissions.

4.9.8 City Planning

Despite its heavily promoted 'outback' image, Australia is the most urban and suburban country on earth. 82% of all Australians live in towns and cities of 25,000 or more, and by 2011 almost 62% will be living in the 5 major state capitals. Planning for 'green cities' and improvement in mass transit systems to reduce car travel and congestion are therefore vital in the fight against carbon emissions.

Painting roads, roofs and pavements white to reflect solar energy is a low cost option to help reduce warming, and firms offering such a service could prosper. Environmental writer Bjorn Lomborg and Steven Chu, the Nobel prize-winning physicist appointed by President Obama as Energy Secretary, both advocate a mass programme of 'painting the world white'.

International experience highlights a range of measures Australia's cities may adopt. Berlin requires three quarters of new buildings to include solar panels while heavily polluted Mexico City is replacing its 80,000 taxis with low-emissions vehicles. Chicago encourages rooftop gardens to keep buildings cool and Copenhagen sees a third of the population cycle to work. Toronto circulates cold water from the lower depths of Lake Ontario to cool more than 30 buildings in the city centre instead of conventional air conditioners, and London's congestion charge has reduced traffic jams by a third and carbon emissions by 15%.

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CASE STUDY

An internal combustion engine converts just 6% of the fuel's potential into acceleration, energy which is then wasted during braking as heat. **Permo-Drive** has created an intelligent hybrid hydraulic system for urban commercial vehicles which saves fuel and so reduces carbon emissions and other pollutants. Its Regenerative Drive System captures that heat to reuse for acceleration by employing a hydraulic pump/motor connected to the driveline, accumulators, reservoir, sensors, hydraulic control manifold through a programmed software controller. The components used are proven, mature technology organised by sophisticated software and controls.

4.9.9 Transport

The 20th century revolution in personal transportation afforded by the private car and international airlines freed much of humanity from a world in which few ventured far beyond the horizon. Although calls to circumscribe car and plane use are increasingly shrill, such draconian restrictions or tax hikes could never prove politically feasible, even if they were environmentally desirable. UK Transport Minister Lord Adonis is among those who reject a 'hair shirt' approach and believes low-carbon vehicles, new generations of aircraft and electrified rail lines are the key. "We'll never sell a low-carbon future to the public if it depends on a deprivation model. I'm convinced that there's no necessary trade-off between a low-carbon future and more or less transport." Though transport contributed 14% of Australia's emissions in 2005, the third largest sector, the broadening of its technology, rather than the corralling of people who wish to use it, is the key to reducing its effect.

Comparatively simple measures, such as longer platforms to allow longer trains and the introduction of double decker carriages, can boost railway capacity in conurbations. Trains are the cleanest form of mass transportation, producing on average a quarter of the carbon per passenger mile of cars and a tenth of that generated by air travel. Thoughtful planning and support for walking, cycling and bus travel can all have real impacts in urban areas. The subsidy of public provision encourages its use, while the effective enforcement of speed limits, and elimination of traffic bottlenecks, reduces the carbon impact of vehicles. A study by NuStats, an American social science research firm, showed the use of real time, traffic enabled GPS technology to allow drivers to avoid jams and accidents could cut journey times by around 20% and save .79 tonnes of greenhouse gases per year.

The provision of company cars in salary packages encourages their use, with larger cars becoming a status symbol at work. Offering city based workers monthly or yearly public transport passes might be more appropriate for their needs.

4.9.10 Transport - Cycling

The humble bicycle can play an important role in reducing city traffic and carbon pollution. More bicycles (1.2 million) were sold in Australia in 2008 than cars (1.01 million) for the ninth consecutive year, and studies of cycling in Sydney show a consistent increase in participation. The City of Sydney has earmarked \$70 million for the building of cycle paths over the next 4 years, and Greens MP Lee Rhiannon has urged the New South Wales Government to do more. In 1999 the State Government pledged funding of \$25 million per year, but is currently only providing \$6.7 million.

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With congestion charging a possibility in Australia's major cities, the price of petrol certain to rise and parking spaces at a premium, the provision of bicycles and accessories is set to be a major retail opportunity. Secure bicycle storage and showers and changing facilities for bike commuters can be provided by employers at a fraction of the cost of new parking.



Toyota has profited from their highly successful Prius Hybrid Car

4.9.11 Transport - Alternative Cars

Petrol and diesel engines have dominated transport for a century, but road transport is currently responsible for 12% of global emissions, and a range of technological innovations have been suggested which may revolutionise the future of the car. From improving the efficiency of standard engines and the use of first and second generation bio fuels to hybrid vehicles and cars powered by batteries, compressed natural gas or hydrogen, the future for designers, manufacturers and servicers of alternative personal transport is assured. Given the unshakable preference for personal transportation in the developed world and the growing affluence of China and India, it is estimated that far from declining, automotive mileage will double by 2050.

CASE STUDY

Better Place Australia is part of a global company dedicated to zero emissions driving. They are working with car and battery manufacturers to ensure a complete, efficient and compelling solution built around electric vehicles (EVs) equipped with a new generation of safe, recyclable and reliable lithium-ion batteries. Their first EVs will be in Australia in 2012.

Although hydrogen fuel cells generate no CO₂, production of the hydrogen itself creates higher emissions than gasoline cars, while the cells are currently costly, fragile and vulnerable to freezing temperatures. Today's hydrogen vehicles have a 25% 'electricity grid to motor' efficiency, given the energy efficiency of water electrolysis (70%), compression (90%) and fuel cells (40%). This compares to an efficiency of 86% for batteries, which again perform badly against petroleum engines in terms of weight, speed, range, efficiency and practicality. The invention of more efficient ways to store hydrogen, perhaps through metallic or crystalline lattices, would transform the industry.

Lead acid batteries are bulky and heavy for the charge they store, but the development of lithium ion technology to power digital cameras and other electronic gadgets in the 1990s has raised hopes they can be scaled up to reduce the weight and extend the range of electric cars. Safety and cost concerns still hamper their introduction, and though Australia has a \$1.3 billion "Green Car Innovation Fund", the development of plug in electric vehicles is excluded from the package.

4.9.12 Transport - Freight

The National Transport Commission recommend the inclusion of transport in an emissions trading scheme to encourage long-term investment in low-carbon solutions. They back the adoption of existing methods to reduce emissions, research into new technology and institutional reform to create more responsive transport markets.

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Road transport accounts for nearly 90% of transport emissions, with passenger cars contributing 62% of that figure and commercial vehicles the rest. Civil aviation, often singled out for blame, contributes just 6% of the overall total. Options for private passenger transport are much discussed, but less attention has been paid to commercial vehicles despite the opportunities for businesses to save on costs and emissions. Road haulage grew by 30% between 1990 and 2005 and is expected to increase a further 27% between 2010 and 2020.

Carbon mitigation measures could include improvements to the urban road infrastructure to reduce congestion and delays, rather than the abandonment of road renewals. An articulated lorry generates 45 times the greenhouse emissions of a car while stuck in traffic. Such road improvements would be expensive and take time to plan and deliver, but the potential for public-private partnerships remains, particularly for choke points such as bridges, tunnels and fast corridors through built up regions. Investment in the urban rail network to provide more rail/road interfaces would encourage a switch from road to rail, with associated emission savings, although rail remains impractical for most short commercial journeys. The replacement of Australia's aging trucks with low-carbon models could be encouraged by a rigorous emissions rating system for commercial vehicles similar to the Government's 'Green Vehicles Guide' for private cars. The scrapping of older trucks has been aggressively pursued in other countries in pursuit of improved air quality. The adoption of natural gas, bio-fuels, hybrids and other technologies could be promoted by demonstrations aping the Federal Alternative Fuels Conversion Programme. A change in commercial driving culture, stressing the need for economy, would bear results, as would better maintenance standards to ensure exhaust emissions are minimised.

Performance based standards to improve vehicle design would stimulate innovation as current crude weight and axle limits do nothing to generate new ideas. Road efficiency would be improved by raising permitted axle loadings, given the better performance of modern vehicles, and could reduce the number of lorries on the road. Lower speed limits tend to improve fuel economy, as optimum consumption is usually achieved between 35 and 80 kph, and the encouragement of night haulage could improve average speeds as daytime congestion is avoided. If night operations were limited to modern vehicles, due to noise concerns, fleets would have a further incentive to upgrade. Finer grained supply chains for freight fuelling would reduce emissions as the centralisation of distribution centres tends to increase overall freight kilometres. Finally, a national ports and terminals strategy to ease links to arterial roads and the rail network would improve efficiency, reduce bottlenecks and therefore cut greenhouse emissions.

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Environmentally friendly transport is more than a way to advertise a firm's 'green' credentials. Tesco runs 1,500 of its 2,000 strong British delivery fleet on a 50% biofuel mix, while mail courier DHL found that using a single 'team bus' in London to drop couriers at a central location and allow them to make deliveries on foot not only cut fuel and maintenance costs, but improved delivery times as couriers spent less time delayed by road congestion. On the other hand, in 2003 the world's largest shipping firm, FedEx, announced its intention to replace its 30,000 medium lorries with diesel-electric hybrids. In the event only 100 were purchased as the company, despite making profits of over \$2 billion US per year, decided the decade long pay off in terms of lower fuel costs could not be justified. Business Week reported a company statement that it could not subsidise the development of such technology for its competitors.

Whatever the scale of the company, sourcing materials and supplies from local producers makes environmental and commercial sense. Many companies continue to use distant suppliers through force of habit instead of investigating cheaper, local solutions which will reduce transport requirements and its consequent carbon emissions.



4.9.13 Manufacturing

Although far from a major manufacturing power, Australia's productive capacity could be made more carbon efficient with the use of existing technology and the pursuit of developments still on the horizon.

Investment in small co-generation plants that capture waste energy to produce electricity on site or the use of storm water or recycled water for the production process can cut costs, as can re-engineering to introduce energy saving tools. The efficiency of basic metals processing can be improved through induction furnaces, high efficiency electric motors and heat recovery systems, while variable speed drives and the replacement of hydraulic systems with electric servos improves non metallic product manufacture and pulp and paper processing. Wood working machinery can be upgraded with high efficiency motors, fans and dehumidifiers, while food processing systems can reduce their emission signature with economy boilers, waste heat recovery systems linked to refrigeration plants, the use of solar heated water for pre-heating and the exploitation of bio-fuels such as tallow or wood.

Not all solutions to climate change need to involve grandiose engineering projects and wholesale reform of the economy. Effective, incremental steps to improve familiar technology can also be made with little impact on consumers. Despite the need to phase out ozone depleting C.F.C.s refrigerator efficiency improved by over 400% between 1972 and 2005, while the efficiency of dishwashers has doubled in the last decade.

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As noted elsewhere, simple measures in every factory can generate immediate dividends through turning off unused motors, computers, space heaters and lights. By installing sensors to turn off fans and lights in vacated areas and replacing conventional conveyor belt motors with high efficiency soft start motors in one of its American distribution facilities, Staples, the office product giant, saved \$100,000 per year, repaying the initial investment in less than a year.

70% of the costs of product development and manufacture are invested at a new product's design stage, and simply adding energy efficiency to the required specifications can reduce the carbon footprint of the product's life cycle while cutting customer energy bills and offering a selling point over rival goods. A sustainable design considers the environmental factors at all stages of a product's development, manufacture and use, including its ultimate recycling or safe disposal. The adoption of "Product Service Systems" as a business model allows companies to transition from selling individual products to lifetime services. For example, carpet firm Interface offers its modular tiles as a 'floor covering service' which can be returned and recycled as new products are ordered.

CASE STUDY

Graphitype printing services exemplify the steps a small business can take in building environmental awareness into every part of its operations. It promotes recycled paper, uses renewable solvents such as orange oil and a new printing plate cleaning process which eliminates 80% of contaminated chemical waste. An investment of \$60,000 in a new press ink delivery system allowed the use of recyclable cartridges and has helped reduce energy bills as have skylights and the shutting down of workstations and factory equipment outside working hours.

The invention and manufacture of low tech energy saving products can generate profits while providing the developing world with affordable, practical solutions, which not only reduce carbon emissions, but save lives. A huge amount of deforestation and desertification is caused by the stripping of arid woodland for fuel. An efficient stove which combusts wood, dung or agricultural waste to cook or purify water uses less fuel than open fires and cuts emissions of carbon dioxide, carbon monoxide, nitrous oxide, methane and soot. Efforts to reduce soot are important as it can rain out on glaciers and ice caps, darkening the surface and speeding their melt. Simple but efficient "rocket" stoves, produced for \$10, can save up to 3 tonnes of CO₂ per year.

Water conservation is a major issue in rural and urban Australia alike. One Australian idea is the "Aqualim", a shower head which rations out an adjustable quantity of water per shower. After the set volume is used, the shower reduces its flow as a warning before shutting itself off. As water metering becomes more common, such simple devices have a large market potential. Another device, the Max Water, is designed to condense water from the atmosphere. Air at 30 degrees, with a relative humidity of 60% contains 18 grams of water per cubic meter and cooling the air by wind powered refrigeration to 5 degrees, will produce 10 grams of condensation. If perfected and marketed at reasonable cost, such an invention would have great commercial potential in arid regions around the globe.

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CASE STUDY

Founded in 1987, **Pro-Pac Packaging** was the first Australian company to offer biodegradable voidfill packaging. Its manufacturing plants in Sydney, Melbourne and Brisbane produce 'Envirofill' and 'Green-Pak' from extruded potato and wheat starch, reusable packaging which is rapidly compostable and does not pollute water sources in landfill.

4.9.14 Retail

Everything from food, textiles and household goods to home renovation and the motor industry will be affected by climate change and the measures adopted to fight it. Although small and medium traders will not be directly affected by the proposed carbon trading scheme, it is inevitable that energy prices will rise whatever its fate and, as tighter legislation increases the cost of water and waste disposal as well, retailers will come under increasing pressure to cut costs.

Efforts to minimise waste and recycle should be integrated into established procedure, with the composting of organic waste, the separation of recyclable waste and the use of recycled or bio-degradable packaging emphasised. Supermarkets already encourage customers to forgo plastic bags to 'save the planet', and such bags have been banned in some countries, notably Ireland, to reduce litter. Brightly lit retail outlets can cut bills by using compact fluorescent, halogen, and eventually LED light sources perhaps powered by roof-top solar panel arrays. The use of alternative fuels and engines for transportation could pay dividends in the future, while energy efficient refrigeration and air conditioning systems would cut costs today. American retail colossus Wal-Mart has vowed to improve the efficiency of its vehicle fleet by a quarter over the next three years and cut 30% of the energy used in its stores in a bid to save \$300 million U.S.

The Victorian Employers' Chamber of Commerce and Industry runs a 'Grow Me Money' educational programme, which claims to save the average business \$4,000, 3.6 megalitres of water and 25 tonnes of carbon emissions.

British supermarket giant Tesco now labels some foodstuffs and household products with a 'carbon footprint' expressed as grams of greenhouse gas emitted from growing, manufacturing, transporting and storing the good. The research, undertaken by the Carbon Trust, showed that liquid washing detergent has a lower carbon footprint than powder or tablets, due to simpler packaging and easier storage, and the higher carbon production costs of energy saving light bulbs are far outweighed by its lower energy consumption as 99% of a bulb's carbon footprint is incurred after its purchase. Crisp manufacturer Walkers are pursuing a similar labelling scheme, while footwear company Timberland includes carbon labels on its shoes.

The retail market for 'green' goods is continuing to expand, but consumers report confusion and mistrust over the wide variety of competing environmental claims. Innovative marketing and the offering of green choices on the widest variety of products, combined with responsible customer

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information, attractive presentation and consistent and credible commercial practices, are key to winning a loyal share of the market. The offering of forest offsets can also appeal to the public's demand for green shopping schemes.



The Government's '**Greenhouse Friendly**' initiative was designed to help businesses and consumers sell and purchase greenhouse neutral products and invest in greenhouse abatement. It was the only Government-endorsed voluntary carbon offset scheme and boasted stringent accounting methodologies. However, it has not proved a success in practice and has been criticised as too complex, convoluted and disconnected from any ordinary business concepts and for concerning itself with individual products, rather than a company's activities overall. Fewer than 20 companies have been accredited since 2002 and the programme is being wound up in 2010 to become part of the Carbon Pollution Reduction Scheme.

4.9.15 Small and Medium Enterprises

Although much of the discussion centres on the major power companies and federal government initiatives, nimble small and medium enterprises (SMEs) are ideally placed to exploit the opportunities change provides. Huge corporations such as Ford or Google began as start ups blessed with a radically more efficient method of production or a product which outperformed the competition at every turn. There is every chance a green Marconi, Microsoft or Apple will create a great Australian success story. SMEs will also provide the bulk of sub contracting services for larger companies or public sector bodies engaged in major projects related to climate change.

Many opportunities for SMEs will come in the 'compliance market' as tighter legislation and new standards force large organisations to re-equip. Measures to reduce smog in Los Angeles in the 1970s, for instance, spurred the development of catalytic converters. It would be riskier to assume the professed environmental concerns of consumers will be translated into purchasing decisions, however. Opposition to factory farming and pesticide use are commonly expressed, but the amount of 'organic' food sold is barely 2% of the total.

While large companies are often wedded to methods which brought success in the past, but are no longer relevant to changed conditions, have large capital investments they are loathe to abandon or change and are hamstrung by shareholder conservatism, SMEs have the flexibility to gamble on radical innovations and trial new models of operation. SMEs can be

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CASE STUDY

Computer giant **Hewlett-Packard** has emerged as the market leader in incorporating a green approach into all aspects of its activities. In 2008, HP was awarded a Green Enterprise IT Award at the third annual Symposium for Green Enterprise Computing in Orlando, Florida, while in 2009 Newsweek placed HP on top of its 'Green Rankings' in the technology sector, noting that it has become the first major IT company to report the emissions of its supply chain. In May 2009 HP also launched 'The Power to Change' campaign to encourage businesses to become more eco-friendly by turning off computers to reduce waste, emissions and energy bills. In 2008 HP launched a green business desktop, the HP Compaq dc5800 Business PC, to meet the environmental requirements of the Electronic Product Environmental Assessment Tool (EPEAT) Gold registry. The new HP ProBook 5310m notebook has also won praise from Greenpeace for virtually eliminating PVC (Polyvinyl Chloride, or vinyl plastic) and brominated flame retardants (BFRs) while in 2007 a new line of storage products reduced cooling costs by 50%. HP has also developed an online interactive tool to allow consumers to understand how eco responsibility has been engineered into all aspects of their operations.

quicker to spot changes in demand and respond to niche markets and, with less bureaucracy to battle, can bring prototypes and new products online faster than much larger firms.

However, SMEs will commonly lack the capability to scale up successful prototypes to meet mass market demands and the funding required for long-term research, development and marketing. They are particularly vulnerable to cash flow problems and cannot bankroll long delays between investment and sales, so will often find themselves relying on government grants or enter into partnerships with large firms, once they have an idea worth pursuing.

Large firms can combine new technologies with a host of existing applications, have the financial resources and manpower to exhaustively test and refine products to meet tight legislative and certification demands and the legal and commercial expertise to protect their intellectual capital on the world stage. The economies of scale open to larger firms will reduce prices and cost is still a primary factor in 'green' consumer and business decision making.

4.9.16 Computing

Although aviation is often blamed for carbon emissions, its percentage of the global total is just 2%, the same as involved in the manufacture and use of computers. The spread of information technology around the world will see that current total of 830 million tonnes of CO₂ double by 2020. On a weight for weight basis, the production of computers is more damaging than the manufacture of cars. 1.8 tonnes of materials, including at least 240kg of fossil fuels, are required to make a standard desktop computer. Computers can usually be upgraded with more memory and new chips at much lower cost than replacing the entire machine, saving money for the company and emissions for the environment. The manufacture of a semiconductor chip creates over 100,000 times its own weight in waste, while a laptop generates 4,000 times its mass in waste.

However, ICT will also play a vital role in monitoring, measuring, analysing and minimising the impact of manufacturing, buildings, vehicle fleets and other operations responsible for a firm's carbon footprint. Technology developed to improve business operations can offer dividends in carbon reduction just as readily as equipment motivated solely by environmental concerns. Home computers can also be employed as smart electricity meters or use spare computing cycles to run climate models. Furthermore, the energy requirements of improved technology dwindle as its capability soars. A modern mobile phone or laptop uses a fraction of the energy required by their much heavier and less sophisticated forebears.

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The onset of computer was supposed to create a 'paperless' office, but in reality the ease of printing has greatly increased the amount of hard copies produced, often for little reward. With all tiers of workers now well accustomed to electronic data, such office printing can often be drastically reduced. Small and medium-sized businesses can increasingly save power and capital costs by switching to distributed 'cloud' computing or create "virtual" machines to allow multiple operating systems to run on the same computer.

'Green ICT: The State of the Nation', a Fujitsu Australia-commissioned research paper, published in September 2009, showed that ICT managers in Federal Government agencies have taken strides in measuring ICT power consumption beyond their counterparts in the private sector. Such concern for 'Green ICT' demonstrates that Government can lead by example as well as exhortation.

A computer uses less than 5% of full power while in 'sleep' mode. Most office computers sit idle for periods in the working day, while workers take a break or attend to other duties, and so setting the preferences to 'sleep' after ten minutes of inactivity would garner significant savings. A computer left on for a year will use nearly 1000 kilowatts of electricity, at a cost of \$125 and a tonne of CO₂. Turning off an office computer at night, weekends and holidays and leaving it 'asleep' when idle can cut bills and emissions by three quarters. It is a myth that turning a computer on and off uses more energy than leaving it on.

4.9.17 Office Practice

The office environment seems far removed from the concerns of heavy industry and mass power generation, yet simple changes in workplace practice can deliver measurable cost and energy savings while improving worker morale.

Beyond the rationalisation of computing, the relaxation of business clothing conventions for 'back room' staff is one simple solution. The traditional business attire of long-sleeved shirts, jackets and ties can prove uncomfortable in Australia's hot climate, forcing energy hungry air conditioners to work overtime. More casual clothing allows offices to operate at higher ambient temperatures and every degree saves air cooling energy. Even a humble cup of coffee can make a difference. 400 million takeaway cups are used and thrown away in Australia each year, while a simple china mug is used, on average, 3000 times. Even allowing for the mug's more complicated manufacture and washing up, disposables generate 30 times more solid waste and 60 times more air pollution.

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It is far easier to move electrons than people, so the often discussed encouragement of 'telecommuting', home working and video and web conferencing should be put into practice wherever it can. Much office work is computer based and can be carried out, at least in part, from home. Home working reduces traffic congestion, transport emissions and saves on workplace energy use which is considerably higher than in domestic dwellings. Workers are also spared long, tedious commutes and traffic analysis shows that even a 4% reduction in car use can eliminate grid lock for the workers who must attend. A shift in office culture to assess performance by productivity, rather than attendance, is required. Flexible home working schemes have the additional benefit of encouraging skilled and experienced mothers back into paid employment by offering the convenience, flexibility and part time hours they require.

German data processing company SVI found set-up costs of €5,500 and monthly running costs of €120-225 per person returned benefits of 300% to 400%, including cost savings of €1,200-1,300 per person at work, increased productivity of 2-5%, the reduction of sick leave by two days a year and savings in recruitment and training costs because of increased staff retention.

Tele-conferencing is still greatly underutilised, despite the inconvenience of travel and the large amounts of working time and expenses it wastes. Just as email has largely replaced the letter and the fax machine, so teleconferencing and high speed broadband video can supersede air and car travel to meetings. British Telecom used video conferencing to replace nearly 900,000 face to face meetings in one year, saving £135 million in travel allowances, £103 million in time and an estimated 97,000 tonnes of CO₂. Bell Canada saves 142,000 tonnes of CO₂ emissions per year through more than 2.7 million teleconferences with their customers.

Lighting accounts for up to a fifth of the energy used in offices, and the efficiency of converting coal into electricity into incandescent light is a paltry 3%. Compact fluorescents cut electricity use by three quarters, last up to six years and, by producing much less waste heat, reduce the burden on air conditioning systems. In 2007, Australia became the first country to signal the phasing out of incandescent bulbs. Their abolition by 2012 will reduce carbon emissions by four million tonnes and cut lighting bills by two thirds. The use of skylights and windows to light the workplace naturally is even more cost effective, especially in sun drenched Australia, and may also increase worker contentment and morale.

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CASE STUDIES

Australian Paper's new ENVI range of paper products, including Acclaim, Bulky Paperback, Environmac and Bulky Cash Rolls, are the first to be certified through the Government's Greenhouse Friendly program. In addition to its internal carbon reduction strategies, Australian Paper have purchased additional offset credits to mitigate unavoidable emissions.

West Australia's **Landfill Gas and Power Pty Ltd** extracts methane for safe, clean and reliable renewable electricity generation from six landfill sites in Perth. Its four waste-to-energy power stations produce 75GWh a year.

EarthPower processes organic food wastes to generate green energy and fertiliser. Its new Sydney facility will process 210 tonnes of food waste a day, generating enough electricity to power 2600 homes and save 106,100 tonnes of greenhouse emissions per year while producing 4500 tonnes of granulated organic fertiliser. Its anaerobic digesters will convert solid and liquid biomass by using anaerobic bacteria to produce methane and liquid effluent which is processed into fertiliser. The biogas fuels generators whose waste heat dries the fertiliser.

4.9.18 Waste Management

Integrating a "3R" approach of "reduce, reuse and recycle" into a company's waste management and material efficiency processes can reap multiple benefits. 80% of products are discarded after a single use, while up to 99% of the original materials used in the production of goods in the developed world become waste within six weeks. Industry mines, moves, burns, pumps and disposes of more than 1,000 tonnes of material to cater for every middle class family's needs every year.

Switching to recycled or sustainably sourced paper, for instance, significantly reduces landfill and carbon emissions. The Waste and Resources Action Programme calculates the average greenhouse gas savings from recycling paper and cardboard to be 1.4 tonnes per ton. A study they conducted in 2005 of 112 companies in London, including BT, Carillion, Ernst and Young, KPMG, Sainsburys and Tate & Lyle found they bought 23,000 tonnes of recycled paper and board saving 53,000m³ of landfill, 690,000,000 litres of water, 621,000 kg of air pollutants and 32,000 tonnes of CO₂.

Australia has been proactive in encouraging the recycling of domestic waste including plastics, paper and aluminium, but the management of landfill to reduce gas emissions could be greatly expanded.

Anaerobic decomposition of organic matter in landfills produces methane, while sewage and industrial wastewater can produce nitrous oxide from its high oxygen content. Up to three quarters of landfill methane can be captured using pipes and wells and used to generate electricity or sold for industrial uses. Although combusting methane creates carbon dioxide, methane is 21 times more potent as a greenhouse gas. Methane capture and generation is currently in its infancy but already generates 125 megawatts of power worldwide, saving four million tonnes of CO₂.

More intensive sorting of rubbish, the recycling of glass, paper, plastic and metal and the composting of organic waste will reduce dumping requirements and save the energy involved in new production. Recycling can reduce emissions by between 3 and 5 tonnes of CO₂ per tonne while composting saves 1 tonne of CO₂ per ton. Firms should, however, factor in the time it takes to sort and recycle waste, as time itself a scarce resource.

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4.9.19 Health Care and Pharmaceuticals

Climate change may affect public health in a variety of ways, increasing the demand for certain drugs and procedures. There could be an increase in respiratory diseases, such as asthma and bronchitis, in warmer urban conditions, while the growth of pollen bearing weeds may exacerbate hay fever and allergic reactions. More seriously, there may be an increase in water and vector borne pathogens in warmer, flood prone regions, notably malaria in the north of Australia, which could spur demand for vaccinations. The funding of expensive, high tech procedures such as heart transplants or joint replacement may be reduced as a result of higher expenditures elsewhere.

4.9.20 Insurance

Insurers face profound risks from the onset of climate change, with the chairman of Lloyd's identifying it as the primary issue for the group. Europe's largest insurer, Allianz, forecasts that extreme weather events could increase insured losses by 37% and cost up to \$1 trillion US in a bad year. Some international insurers are refusing to insure homes along hurricane prone coasts or in areas threatened by wildfires. American firm Allstate, for example, cancelled or refused to renew policies in Gulf Coast states claiming recent hurricanes had wiped out the profits of 75 years of home policies. Companies are increasingly 'hollowing out' policies through increased deductibles, new exclusions and reduced upper limits, or are refusing to cover hotels and the energy sector.

More progressive firms have moved beyond minimising risks to actively encourage climate change solutions. Several major companies have formed specialist departments including AIG's Global Alternative Energy Practice, Allianz's Climate Solutions, Aon's Agri-Fuels Group and Chubb's Green Energy Team. Activities which improve disaster resilience, energy efficiency programmes, green building designs and sustainable vehicle use can all be encouraged through insurance price signals.

Australian insurers should engage in detailed climate modelling to predict regional vulnerabilities and tailor policies to encourage policy holders to adopt mitigation measures, which will in turn reduce claims should extreme weather strike. Without such steps, many regions may become uninsurable with grave social consequences if storms, fires or floods decimate people's lives and property. The provision of micro insurance to small farmers in the third world is also being expanded, opening new markets and offering a life line to those most at risk from climate change.

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Pay as you drive insurance is now common, rewarding limited car use, and drivers of hybrid cars are seen as good risks and rewarded through premium discounts. AIG offer 'Green Buildings' insurance, while London based Willis Holdings covers potential underproduction from wind farms. 38 insurance organisations have joined the ClimateWise programme to promote proactive market responses to climate change, and several large companies have pledged to become 'carbon neutral' through the purchase of carbon offsets.

There is still far to go, with only a tenth of insurers actively researching the new risk environment and one third offering climate change related insurance. The liabilities of new facilities, such as sequestered carbon dumps are, like the technology, still at an early stage.

Australian insurers must show thought leadership as Australia is likely to be one of the first and worst hit countries, with highly valuable assets vulnerable to coastal storms, flooding and fire. Firms must embrace climate conscious underwriting and manage risk by reinsuring with the capital markets. Public-private partnerships to improve storm and flood defences are to be encouraged, and insurability of high risk regions may only be possible in the future through private-public initiatives.

4.9.21 Clean Tech

Clean Tech describes knowledge-based products and services that improve operational performance while reducing costs, inputs, energy consumption, waste and pollution. As the economy is challenged by high energy prices, resource shortages, global environmental problems and security threats, clean technologies are the engine of economic growth and the key to sustainability.

There are opportunities in offering "clean tech" investment funds. The Dow Jones already publishes a 'Clean Technology' e-newsletter, superannuation funds are targeting the sector, and a growing percentage of investors now opt for clean tech funds in their portfolio. The Australia-Israel Chamber of Commerce launched an online portal mapping Australian clean technology companies in September 2009. Supported by Ernst & Young, the Export Finance and Investment Corporation and Austrade, the **Australian Cleantech Industry Portal** links over 500 Australian companies in the sector.

Another organisation, the **CleanTech Sydney** group, comprises a range of environmentally positive companies focused on the employment of modern technological to solve environmental problems using "triple-bottom-line" solutions. The group is working with Industry & Investment NSW to form an Industry Cluster in Sydney and promoting the Eco Investor Forum.

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Venture capital has poured into new energy sources in recent years, topping \$2.4 billion U.S. in 2006. John Doerr, a leading Silicon Valley venture capitalist who helped finance Google, Amazon and Sun Microsystems, has termed clean energy 'the largest economic opportunity of the 21st century'. The World Bank has officially approved two climate investment funds – a Clean Technology Fund and a Strategic Climate Fund to which the UK, U.S. and Japan have pledged up to \$5 billion.

CASE STUDIES

Carbon Planet is an Australian carbon management company that sells certified carbon credits, provides greenhouse gas audits and offers carbon reduction advice to help businesses reduce their emissions. Carbon Planet offsets its own operations and is carbon neutral.

Energetics is an integrated climate change, energy/water efficiency and sustainable solutions provider with offices in Sydney, Canberra, Melbourne, Perth and Brisbane. The carbon neutral company supports clients from risk assessment to developing solutions and capitalising on new low carbon opportunities.

4.9.22 Carbon Services

Given the complexity of the issues involved and the significant benefits which can accrue to businesses which position themselves correctly, there are increasing opportunities for consultants to advise companies on carbon related issues.

Services may range from basic staff education to the navigation of the maze of domestic legislation and international strictures which affect a particular firm. Factory energy and waste audits, the compilation and maintenance of emission inventories, long-term strategic advice or low cost grass roots technical solutions can be offered by consultants re-skilling from other areas or by businesses, which have already successfully tackled their own carbon issues and have best practice to share.

4.9.23 Employment Prospects

The 2006 Stern Report predicted that a “massive shift towards low-carbon technologies will be accompanied by a shift in employment patterns. If it is assumed that jobs rise from the current level of 1.7 million in line with the scale of investment, over 25 million people will be working in these sectors worldwide by 2050.” A slowing of investment in carbon intensive industries, due to fears of future carbon pricing or legislation, is a greater threat to jobs than outright closure. In April 2009, Shell threatened to cut investment in Europe if it was not given free emission allowances under the third stage of the EU's emission trading scheme, due to be launched in 2012.

There are lessons to be learned from Europe where the carbon trading market proposed for Australia is already established. Jobs lost after German and Danish shipyards closed in the face of South Korean competition have been partially replaced by opportunities in the countries' much vaunted wind farms.

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4.9.24 Reporting Results

Companies must be transparent in reporting the results of their environmental initiatives to avoid the widespread public suspicion of 'greenwashing' business as usual. Such publicity can improve the company's image and drive sales more effectively than traditional advertising, while internal reporting of progress and savings acknowledges the contribution of the workforce and motivates continuing effort. External reporting can also encourage investment from state and city pension funds, charitable and other foundations, religious institutions and socially responsible investment firms. Independent tools for verification and reporting include the 'Global Reporting Initiative', whose G3 guidelines provide protocols to measure, track, assess and communicate progress on energy use and emission liabilities.

4.9.25 Federal Environmental Business Grants

The Federal Government provides a wide range of grants and assistance through various departments and organisations to encourage environmentally friendly business investment, innovation and reform. Most notably, the Green Building Fund, the Climate Ready Program and the Re-tooling for Climate Change Program comprise the \$240 million Clean Business Australia initiative. They represent a host of opportunities for businesses to ease their transition to reduced carbon operations.

The Green Building Fund is administered through AusIndustry and offers assistance for the energy-efficient retro-fitting of existing buildings and training initiatives to improve the skills of building operators. Worth \$90m over 5 years, it aims to reduce the impact of Australia's commercial buildings by reducing the energy they consume. AusIndustry's 4 year, \$75 million **Climate Ready Program** is a competitive scheme providing grants from \$50,000 up to \$5m on a matching funding basis to support research and development, proof-of-concept and early-stage commercialisation activities offering solutions to the challenges of climate change. The **Re-tooling for Climate Change** programme provides grants to improve manufacturing processes by increasing energy and water efficiency and cutting carbon emissions. Aimed at small and medium sized Australian manufacturers, its support can range from \$10,000 to \$500,000, covering up to half the cost of each project.

Other programmes target alternative fuels, energy efficiency and low-carbon research and development. The Department of Agriculture, Fisheries and Forestry (DAFF) funds research, communication and training to prepare the agriculture sector through the **Climate Change Research Program**, while

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its **Climate Change Adjustment Program** offers primary producers professional advice, training and adjustment assistance. The **Cooperative Research Centres (CRC) Program** of the Department of Innovation, Industry, Science and Research (DIISR) links researchers with industry to share knowledge on environmental management and ecologically sustainable development and offers industry-specific education programs. The **Energy Efficiency Opportunities** program administered by the Department of Resources, Energy and Tourism (RET) is mandatory for companies using more than 0.5 petajoules (PJ) a year.

The **Cleaner fuels grant scheme (CFGS)** offers payments for businesses that manufacture or import eligible cleaner fuels and register with the Australian Taxation Office (ATO), whose **Energy grants credits scheme (ECGS) - alternative fuels** gives grants to businesses using particular fuels for specified activities. **Ethanol Production Grants (EPG)** are offered by AusIndustry to eligible Australian ethanol producers to support the use of transport bio fuels. The **Second Generation (Gen 2) Biofuels Research and Development Program** is a competitive grants program which supports the research, development and demonstration of new bio fuel technologies and feedstocks and is administered by the Department of Resources, Energy and Tourism (RET). AusIndustry's **LPG Vehicle Scheme (LPGVS) - LPG Conversions** gives rebates to vehicle owners who convert their vehicles from petrol or diesel to LPG and its **LPG Vehicle Scheme (LPGVS) - New LPG Vehicles** offers rebates to owners who convert a new vehicle to LPG before its first registration. The Australian Tax Office's **Product Stewardship for Oil (PSO) Program** provides benefits to eligible recyclers and users of recycled oil.

The Green Car Innovation Fund was opened for applications on 24 April 2009 by Minister Carr and is part of the Government's **New Car Plan for a Greener Future**. The \$1.3 billion scheme will provide assistance over the next decade to Australian companies for projects which reduce the fuel consumption and emissions of passenger vehicles. Grants are provided at a ratio of \$1 of government funding for every \$3 of eligible expenditure contributed by the grantee.

The Department of the Environment, Water, Heritage and the Arts administers a range of **Low Emissions Technology and Abatement (LETA)** programs supporting the identification and implementation of cost effective abatement opportunities and the uptake of small scale low emission technologies. It also provides rebates through the **Renewable Remote Power Generation Program (RRPGP) - Renewable Energy Water Pumping Sub-program (REWPS)** for business, government and other incorporated

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organisations in Western Australia to support the installation of renewable energy water pumping systems. The related **Residential and Medium-Scale Sub-program** offers rebates of up to half the capital cost of renewable generation and essential enabling equipment in Western Australia to support the installation of renewable generation systems. A range of programmes are also offered by State and Territory Governments.

4.10 The Marginal Cost of Greenhouse Gas Abatement

A widely cited study by McKinsey in 2007 attempted to calculate the global greenhouse gas abatement potential per sector.

Figure 2. Abatement potential for greenhouse gases by sector, GtCO₂e per year by 2030 (costing up to €40 per ton)

Sector	Abatement potential Gigaton of CO ₂ e	Possible abatement measures (examples)
Power	5.9	<ul style="list-style-type: none">- Renewables (wind, solar, - biomass)- Nuclear- Carbon capture and storage
Manufacturing	6.0	<ul style="list-style-type: none">- Energy efficiency (e.g. cogeneration, process shift)- Fuel switching (e.g. biofuels)- Carbon capture and storage in industrial process
Buildings	3.7	<ul style="list-style-type: none">- Improved building insulation, heating/cooling efficiency- Energy efficiency in lighting, appliances
Transportation	2.9	<ul style="list-style-type: none">- Fuel-efficient vehicles- Biofuels
Forestry	6.7	<ul style="list-style-type: none">- Deforestation avoided- Afforestation/reforestation
Agriculture/ Waste	1.5	<ul style="list-style-type: none">- Capture of methane from landfills- New agricultural methods without tillage reducing emissions from the soil
TOTAL	26.7	

Source: Enkvist *et al.*, McKinsey & Company, 2007

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The abatement potential for transportation highlights **fuel efficiency** as a key measure with a negative cost of abatement, although the report did not consider further savings from a shift from private transport (cars) to more fuel efficient per passenger mile buses and trains. The author of the study, P.A. Enkvist, noted that “in a 25-year perspective, power generation and manufacturing industry offer less than half of the potential for reducing emissions” and that “almost a quarter of possible emission reductions would result from measures (such as better insulation in buildings) that carry no net life cycle cost in effect, they come free of charge.”

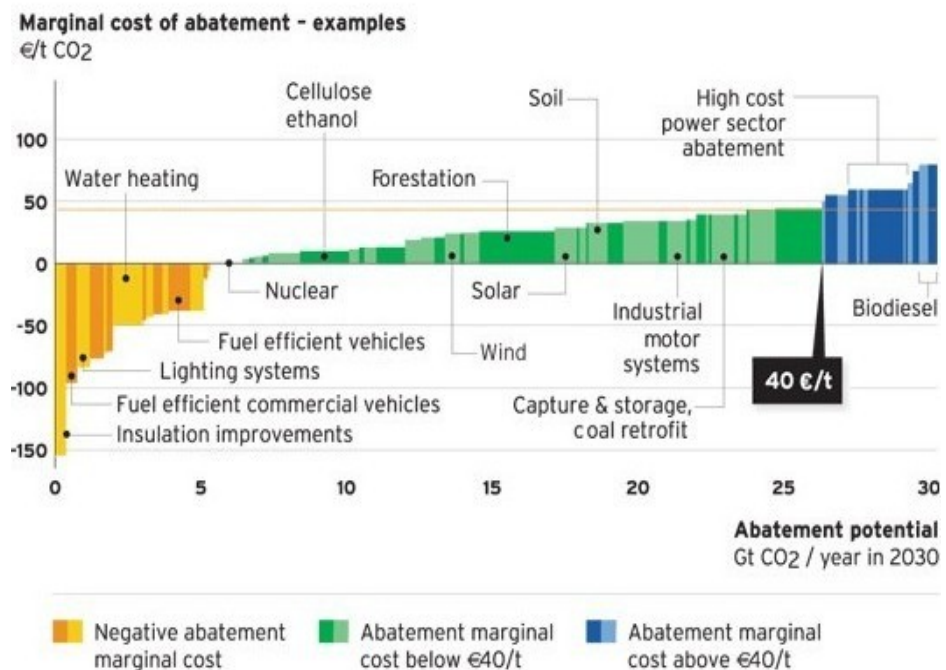
The study concluded that “a substantial share of the overall opportunities, including a large potential to reduce emissions by protecting and replanting forests, lies in developing economies.” (P.-A. Enkvist *et al.*, A Cost Curve for Greenhouse Gas Reduction p36). The study also noted that **nuclear power**, an option not considered by the Australian government despite Australia’s large uranium reserves, is the most cost effective method of reducing emissions from electricity generation.

The cheapest abatement strategies involve energy efficiency measures, but these are insufficient in themselves to deliver the necessary reductions in emissions. McKinsey’s report concludes that a target of 450 ppm could be achieved at a cost of the equivalent of \$64 Australian per ton, giving an annual worldwide cost of \$800 billion per year, approximately 0.6% of the world’s predicted GDP. Even if more expensive abatement measures were required, it estimated the cost at no more than 1.6% of world GDP.

A recent study for the Swedish energy company Vattenfall AB, using consultancy input from McKinsey, highlighted the widely varying marginal costs of abating a tonne of CO₂.

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Figure 3. Global cost curve for greenhouse gas abatement measures



Source: Vattenfall AB, 2008

While measures, such as better building insulation and efficient lighting and transportation, actually save money, many methods which are favoured as promising sources of GHG abatement, such as biodiesel and carbon capture and storage, are exposed as highly expensive. Carbon pricing at AUD \$34 per ton of CO₂ equivalent could realistically achieve a carbon zero position in commercial office buildings at no net cost, and the McKinsey cost curves suggest that this would be worth a negative abatement of \$5.2 billion to the Australian economy.

In regard to global aggregates, the report found that 7 Gtons per year of CO₂ abatement is available at negative or zero cost, mainly through energy efficiency and nuclear electricity, while 27 Gton per annum is available below \$64 Australian per ton, enough to deliver a 46% emissions reduction relative to a “business-as-usual” scenario. It estimated that such a reduction would stabilise atmospheric CO₂ levels at 450 ppm. The analysis found that several commonly held ideas regarding abatement opportunities were not supported by the available evidence. The industrial and power sectors

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represent less than 45% of the total 2030 abatement potential, for instance while, far from being exorbitantly expensive, between 35% and 45% of abatement opportunities in the developed world have zero or negative costs. Only 30% of the 2030 abatement potential depends on the creation of new technology, and stabilising carbon dioxide at 450 ppm could cost as little as 0.6% of GDP if all low-cost opportunities are addressed.

A report published by McKinsey in 2008 focusing on an “Australian cost curve for greenhouse gas reduction” concluded that Australia’s emissions could be radically reduced to 30% below 1990 levels in 2020 and 60% by 2030 ‘without major technological breakthroughs or lifestyle changes’ through the employment of existing and improving technology. The reduction outlined for 2020 could be achieved at a cost of A\$290 per household, if all opportunities priced at A\$65 were utilised at a total cost of A\$2.9 billion per annum.

The report believed that a quarter of the reductions could be realised with positive net returns through **energy savings** from better insulation and fuel efficiency. Such an optimistic scenario depended on prompt action by government, business and public to embrace “regulation and incentives, fast tracking the commercialisation of key technologies, accelerating effective information campaigns to drive changes in consumer behaviour and establishing an integrated national scheme to motivate carbon reduction while maintaining the competitiveness of key industries”.

The greatest abatement opportunities lay in **power generation** (39% of the total), **forestry** (31%) and **building and industry** (11% each). The report identified the ending of widespread land clearing in Australia as a ‘large, immediate and perishable opportunity to reduce GHG emissions’. The building sector offered a net benefit of A\$130 per tonne, while **transport** offered A\$65. Overall, the report estimated the long term marginal cost of abatement to range between A\$65 and A\$70 per tonne.

McKinsey estimated that savings of 221 Mt CO_{2e} were achievable in the power industry by 2030 at an average cost of A\$40 per tonne of CO_{2e} with reductions of 172 Mt CO_{2e} in forestry at a similar cost. 63 Mt CO_{2e} in industry and 25 Mt CO_{2e} in agriculture could be saved at a net cost of just A\$5 per tonne while cuts of 23 Mt CO_{2e} could be achieved in transport with a net benefit of A\$65 per tonne. The building industry could adopt better insulation and energy efficient design to save 60 Mt CO_{2e} while generating net benefits of \$130 per tonne.

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Although the McKinsey report's optimistic figures do not rely on the development of speculative technology, it does assume that two thirds of Australia's coal fired power stations will be fitted with effective carbon capture and sequestration technology in two decades time, with half of today's plants retired and replaced by new CCS plants situated near suitable storage sites. It assumes that onshore wind power generation can account for 15% of Australia's power needs and that geothermal power will produce a further 8%. Given the minimal contribution of current wind and geothermal techniques and the huge technical, practical and financial implications of coal fired CCS, such figures must be seen as very much a best case scenario. If CCS proves impractical, the use of renewable sources would have to climb to more than a third (35%) by 2020 and two thirds by 2030, including contributions from solar, wind, geothermal and biomass, to achieve the cuts required. The adoption of nuclear power, a proven and mature, if highly controversial technology, to account for 10% of Australia's needs would reduce the cost of abatement by 12% in the pursuit of a radical 60% cut of emissions on 1990's figures by 2030.

The savings possible in the forestry sector are less speculative in nature. A firm commitment to further slow and ideally halt the land clearing which has contributed so much to Australia's emissions and other environmental problems is vital if Australia is to meet its obligations. The reafforestation of denuded and marginal land is another proven, low cost and effective carbon abatement measure with a host of other advantages in terms of soil preservation, wildlife conservation and agricultural sustainability.

The reductions in industrial emissions depend on improving the efficiency of electrical motors and reducing methane emissions from black coal mining and natural gas extraction. The low net cost of these measures results from the use of methane as fuel or in other processes.

The improvements in the building industry, which the report hopes can produce significant cost savings, are again based on provable returns from better air conditioning and water heating systems. Given the expense of retrofitting existing buildings, the employment of more fuel efficient systems depends on government regulation mandating their use and incentivising developers to adopt them.

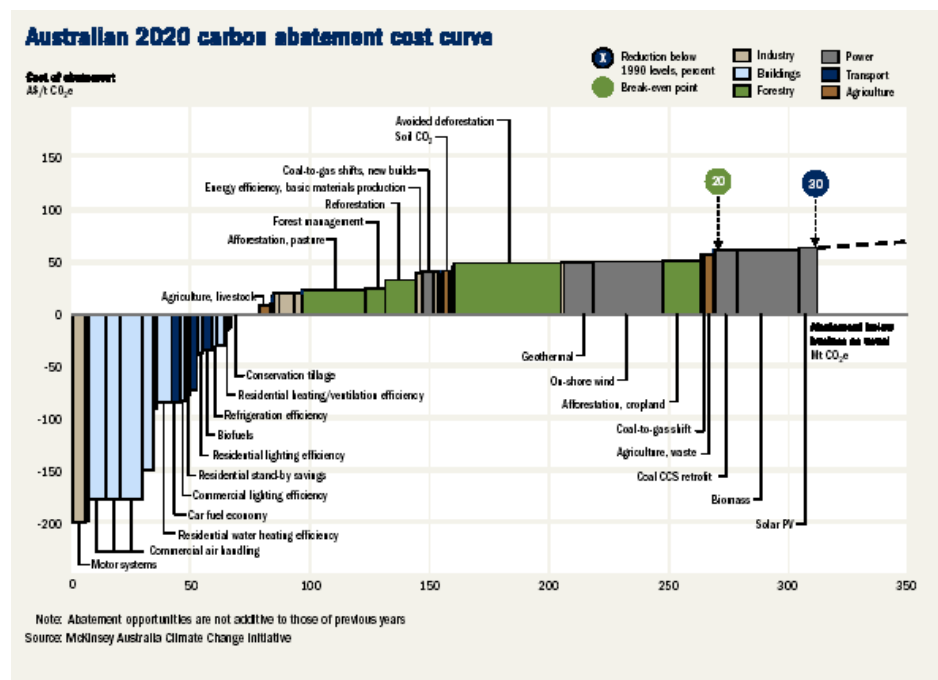
Improvements in the performance of the agricultural sector depend on the adoption of 'conservation tillage' to reduce ploughing prior to planting, better fertilisation and the capture of methane generated by landfill. Methane from livestock can be reduced by new feeds while more sensitive tillage will reduce erosion and the amount of water wasted.

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The carbon savings in the transport sector generate savings for users, given improvements in fuel efficiency, the use of bio-fuels and a widespread adoption of 'plug in' electrical power plants for commercial vehicles.

If carbon and cost savings from investment in Certified Emissions Reductions schemes abroad were factored into the calculations, McKinsey estimate that the cost of abatement in 2020 could be reduced by almost 80%. The most obvious opportunity is the prevention of rampant deforestation in Indonesia, a country not constrained by carbon reduction agreements. Tropical deforestation releases huge quantities of carbon dioxide with minimal economic benefit and investment in preserving Indonesia's remaining forests offer a cheap, effective, achievable method of reducing emissions while preserving bio-diversity.

Figure 4. Australian 2020 carbon abatement cost curve



Source: McKinsey Australia Climate Change Initiative

PART FIVE - Alternative Approaches

5.1 Personal Carbon Trading

Personal carbon trading would involve emissions credits being allocated to individuals, rather than companies, which would be 'spent' to purchase energy. Those wanting more could purchase extra credits, while those who consumed less could sell theirs. Tradable Energy Quotas were devised by environmental writer David Fleming in 1996, while Personal Carbon Allowances were outlined in "How we can save the planet" by Mayer Hillman and Tina Fawcett. Tradable Personal Pollution Allowances, proposed Dr Kirk Barrett in 1995, would apply to any form of pollution, including greenhouse gases. The credits would be held in 'virtual' accounts and surrendered automatically on purchasing fuel, electricity or, perhaps, using transport. Proponents of such schemes hold them to be fair and useful in encouraging all citizens to engage with the issue, while opponents criticise their complexity, cost and oppressive overtones.

Personal Carbon Trading would tend to redistribute wealth from rich to poor, as those with higher incomes use more energy and would have the money to buy credit from those who used less, while a direct carbon tax would inevitably be regressive in nature. Research carried out for the Brotherhood of St Laurence shows that wealthy Australian households generate almost 58 tonnes of greenhouse gas per annum, while poor families produce just 22. A 'pre-feasibility' study by DEFRA in Great Britain concluded in May 2008 that "personal carbon trading has potential to engage individuals in taking action to combat climate change, but is essentially ahead of its time and expected costs for implementation are high".

Improving home insulation, buying a modern gas boiler, minimising air travel and driving, using low electricity appliances, eating locally produced, unprocessed food and recycling grey water and waste can all reduce an individual's carbon footprint, but Australian commentators, from the left-wing Australia Institute to the pro-market Institute of Public Affairs and the Centre for Independent Studies, observe that, under the CPRS, the more concerned individuals save on their emissions, the more corporate polluters, such as coal fired power stations and aluminium smelters, would be allowed to emit.

5.2 Geo-engineering

"Everyone's always complaining about the weather but nobody does anything about it", goes the old saw, but there is no shortage of schemes proposed to "hack the planet".

PART FIVE - Alternative Approaches

The systematic clearing of forest since the invention of agriculture and the pumping of billions of tonnes of greenhouse gases into the atmosphere since the industrial revolution has essentially been a huge, unintentional exercise in geo-engineering, and many scientists and engineers have suggested 're-engineering' the planet to ameliorate those effects. It is striking that the environmentalists who paint the bleakest scenarios of the future are also those most vehemently opposed to equally massive projects to counter it. Greenpeace, for example, reject geo-engineering on the basis that "intervening in our planet's systems carries huge risks" and will "undermine" the need to continue emission reductions

Vast engineering schemes could buy time for economies wedded to carbon, although many proponents of geo-engineering despair that well-meaning talk of emissions limitation will ever be translated into action, given the developed world's reluctance to sacrifice its comfortable lifestyle and the developing world's understandable determination to pursue rapid economic growth. Climate engineering does not require the unanimous agreement and honest participation of all the world's major economic powers, indeed in the absence of meaningful international action one determined nation, or alliance of nations, could take action on their own.

Climate engineering could take many forms, from cooling the planet with sun-blocking particles or shades to altering the composition of clouds to make them more reflective of solar energy. There are also various schemes to physically removing vast quantities of carbon from the atmosphere. If geo-engineering is to be employed, then, like carbon emission reductions, it is likely that several projects will contribute their share, rather than a single 'silver bullet' bringing the crisis to an end. Governments of many nations have invested sizable sums in emission reduction and alternative energy research, yet virtually no public money has been allocated to geo-engineering projects, which might prove the more technically feasible and economically viable options in the end.

Sulphate aerosols fired into the stratosphere from volcanic eruptions, such as Mount Pinatubo in 1991, have caused global cooling of between 0.5 and 1 degree on several occasions, and Ken Caldeira of the Carnegie Institution for Science favours the use of aerosol particles seeded by aircraft to reflect shortwave solar radiation back into space. A report from the Novim research organisation suggests that cooling the planet in this fashion until emission reduction began to take effect would cost \$8 billion per year.

PART FIVE - Alternative Approaches



**Phytoplankton bloom
in the South Atlantic**

Such a scheme would not be without risk, with a paper by Gabriele C. Hegerl and Susan Solomon published in 'Science' noting a drop in global rainfall after the eruption of Mount Pinatubo. However, small scale testing, perhaps over the threatened arctic icepack, might be preferable to a worst-case scenario in which, as Mr Caldeira explains, "you have an untested system that you need to deploy quickly at large scale in a desperate attempt to ward off some sort of climate crisis. It could be much better to start testing soon at small scale and to observe what happens as the system is deployed."

Other ideas include the use of 'cloud ships' to spray mists of sea water into low lying clouds to increase their albedo (reflective index) to reflect more of the sun's energy back into space. Such relatively simply cloud-brightening technology could counter a hundred years of global warming for \$9 billion, according to J. Eric Bickel and Lee Lane, who found it the most promising form of climate engineering in a report published by the Copenhagen Consensus Centre. Alternatively, the cloud ships could patrol the Pacific, firing seawater into the air where it would evaporate to leave salt crystals to float up on rising air currents. The crystals would then form a nucleus, around which water could condense to increase cloud cover and so reflect more sunlight. One consequence of the terrorist attacks of 2001 on the United States was the grounding of domestic passenger aircraft. The subsequent lack of vapour trails caused a noticeable fall in cloud cover and therefore increased the percentage of sunlight which reached the surface of the earth. Such schemes could be used in conjunction with the mass whitewashing of roads and roofs, as mentioned previously, to reflect more of the heat currently absorbed by darker materials.

The use of giant pipes to mix colder, less dense sea water with warmer surface water to disrupt the formation of hurricanes and potentially cool the oceans has been suggested by, among others, Bill Gates. The seeding of the oceans with iron filings, to promote blooms of plankton which would utilise carbon then sink to the sea bed has been tested in various trials since 1995, most recently LOHAFEX from January to March 2009 in the Southern Atlantic.

The capture of atmospheric CO₂ could be undertaken at a similar cost to that of emission taxation. Britain's Royal Society recently published a study which advocated the erection of 100,000 strong forests of 'artificial trees' to absorb excess CO₂ and allow it to be safely sequestered underground. Prototypes of the artificial tree are the size of a shipping container and remove thousands of times more CO₂ than a real tree.

PART FIVE - Alternative Approaches



A more outlandish proposal is the idea of launching of huge numbers of small glass reflectors by rail guns into space to shade the earth from the sun. The L₁ Lagrange point could host enough particles to form an 1800 km diameter parasol, reduce solar radiation by 2% and thus win time for emissions reductions to take effect at a cost of \$5 trillion (U.S.).

"Climate change is shaping global markets and global consumer attitudes. There will be winners and losers. Companies who seize the opportunities, who adopt strategic environmental, social and governance policies and who evolve, innovate and respond to these challenges are likely to be the pioneers and industry leaders of the 21st century" (Achim Steiner, Executive Director, United Nations Environment Programme).

5.3 In Conclusion

Despite the most doom laden predictions, history offers hope that human ingenuity can devise and deliver a sustainable, low-carbon future given the requisite political will, public support and economic incentives. For all its human catastrophes, the 20th century proved the ability of free markets to lift whole nations free from want and privation, while science, engineering and technology achieve wonders beyond imagining. The 21st century in turn will rise to the scientific, economic and environmental challenges of climate change. The opportunities to capitalise on the growing demand for low-carbon solutions are legion, and forward-thinking businesses will not only survive, but profit and grow, while those which prove an obstacle to progress risk being swept away.

APPENDICES

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Australian Government's White Paper "Carbon Pollution Reduction Scheme: Australia's Low Pollution Future", released 15 December 2008

Research by Dr Ben McNeil, Climate Change Research Centre, University of NSW – economic implications of climate change and opportunities for Australia to move to a low carbon economy ("The Clean Industrial Revolution: Growing Australian Prosperity for a Greenhouse Age", Allen & Unwin, May 2009)

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Presentation by Craig Bathie, Field Force (UXC) "Summary of State and Federal Renewable Energy and Greenhouse Schemes"

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