

# *Climate Change and Peak Oil: Problems and Solutions*



*by*

*Alison Kennedy. B. Sc.*

*Education Officer*

*Climate Change Australia*

*Hastings Branch*

*November 2008*



# Contents

- Contents ..... 2
- Introduction..... 3
- Part 1. .... 3
  - 1a. What problems associated with climate change are currently being experienced or are likely to escalate in relation to the use of fossil fuels as the main energy source?..... 3
- Part 2. .... 5
  - 2a. Given that the end of oil or ‘peak oil’ is a looming reality, explore the viability of alternative sources of energy available, which could replace fossil fuels. .... 5
  - 2b. As well, critique measures taken by the government to address this issue – e.g. emissions trading scheme, carbon offsets and carbon credits. .... 6
- Part 3. .... 9
  - 3a. Therefore, what actions can we take to lobby our governments to act decisively now? ..... 9
  - 3b. What direct actions can we take as citizens to facilitate the necessary transition to using alternative sources of fuel as a means of rapidly reducing greenhouse gas emissions –to avert impending disasters and move to a carbon neutral economy? ..... 10
- Conclusion ..... 10
- References..... 11

## Introduction

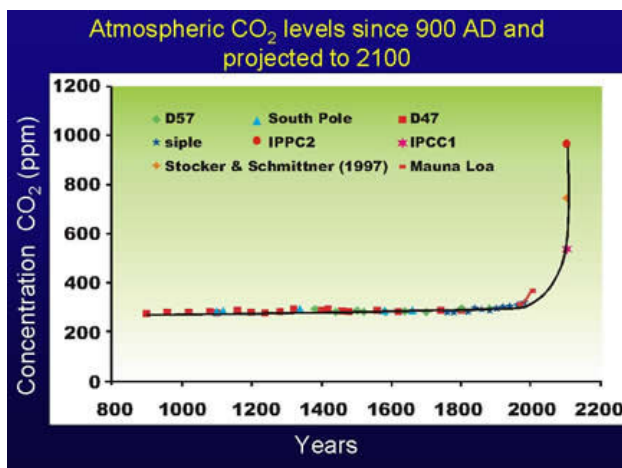
This essay examines the interface between the effects of global warming and the looming 'peak oil' crisis; and neo-liberal political tactics and alternative courses of action (Alternet, 83057). It looks at the neo-conservationist 'fight or flight' reactions that are driving global politics and wars, other more mature alternatives, why we are resistant to them, and how we can achieve them if we act now. These issues are addressed in three parts: the problems; the solutions and our government actions; and how individuals can influence government decision-making processes.

### Part 1.

#### 1a. What problems associated with climate change are currently being experienced or are likely to escalate in relation to the use of fossil fuels as the main energy source?

The consensus of scientific opinion is that Global Warming is caused by anthropogenic activities, particularly since the commencement of the industrial revolution. Global Warming is caused by the Greenhouse Effect – the ability of six atmospheric gases (including water, methane and carbon dioxide) to absorb and reflect infra red radiation. Ice core samples going back 400 000 years indicate that an exponential rise in both atmospheric carbon dioxide and temperature is taking place at present and that it commenced in the 1850s, which is when we began to seriously burn coal and oil for electricity and engines. Carbon dioxide contributes 50% of the capture of infra-red radiation (SAHFOS, 2008) that causes the Greenhouse Effect. acting like an extra blanket on a bed. The rapid burning of the Earth's fossil fuels has increased the average temperature four fold since 1850 and the world is currently warming exponentially (Canadell, Global Carbon Project, 2008). The oceans have absorbed 50% of this excess gas, and the soils have absorbed 25% (SAHFOS, 2008). Both are at saturation point and the chemical processes that support ecosystems are breaking down. There is no doubt that at ground level we are experiencing changes in rainfall patterns and soil moisture content, hotter summers, more bushfires and more intense cyclones.

Carbon dioxide levels have oscillated between 200 and 280 ppm for hundreds of thousands of years yet they were 360ppm in 2000 and are predicted to reach 540-970 by 2100 if we continue with current developmental trends. Graph 1, below, indicates the gravity of the situation.



Graph 1. Depicts the sharp rise in CO<sub>2</sub> since industrialization.

Source:  
<http://www.sahfos.ac.uk/Climate%20Encyclopaedia/co2.html#>

On top of the Global Warming crisis, we have the threat of Peak Oil. Instead of looking at how to solve both problems simultaneously, for they have the same cause (fossil fuels), countries like America and Russia are aggressively instigating 'oil wars', wasting the oil we do have left, and causing global insecurity (Daalder,2007). This is even further exacerbated by the instability of the global financial markets. All of these problems have the same root causes: an insatiable thirst to have an easier, more comfortable life: the search for security and meaning that fosters greed and avarice.

Although the poorest countries will be hardest hit by the effects of Global Warming, like rising sea levels, melt-water floods, and prolonged droughts; most of the richest countries are the least buffered against oil shortages. We have the least number of people growing their own food, the least forms of non-motorised transport, the least alternative forms of irrigation etc. We rely upon oil for transport for every industry. Therefore, Peak Oil looms as a huge threat, one we are prepared to fight and destroy over (Global Issues, 2008). We are escalating the Climate Change problem by continuing to clear the Amazon to find more oil and minerals, by building a new coal fired power station every week in China, by expanding coal mining in Australia (Planning,2008), by transporting food items an average of 1200 km, by shipping raw materials to other nations then shipping the products back again. We continue 'business as usual' as the fuse burns down on the time bomb, a bomb of our own creation. Every environmental prediction caused by global Warming is actually caused by using oil and coal at the rate of 400 years worth per year (ie it took 400 years worth of plant matter to make the amount we use in a year). We are causing the largest mass extinction ever. Rainforests are dying of over-drying, beaches are eroding, Islanders are being evacuated already. Residents of Bangladesh are being displaced by waves, with nowhere to go. "The prognosis for the future, without a radical change in living habits and major technological developments, is not bright, given that global energy demand over the next 25 years is expected to increase by 60%" (SAHFOS, 2008).

**1b. Explain the political-economic challenges arising due to the consequence of scarcity as fossil fuels are being continuously depleted.**

As a civilization dependent upon oil, we use it for most activities that supply us with food, water, transport, education, medicine, administration, consumer goods and recreation. Especially in Australia, which is heavily dependent upon coal for its power; oil and coal drive our manufacturing, housing, tourism and agricultural industries. As oil becomes scarcer and prices escalate, it will affect our ability to manufacture fertilizers, plough our vast paddocks, harvest, process and transport our foods. On top of this threat, Global Warming is changing the rainfall patterns and temperatures and therefore the best food growing locations and seasons. The more oil, iron ore, bauxite and coal we use, the more carbon emissions we create. As Peak Oil looms, the oil importing countries are all too aware of their vulnerability. They have two choices in how to react: either become oil-independent, like Sweden is doing (People and Planet, 2008), or fight for control of the remaining oil. The Iraq war and the Georgia war are resource wars – wars over access to oil. There will be many more conflicts as water, food, oil and territory become scarcer as the Earth warms up. The West has created this big demon called Terrorism, lurking in the shadows, when the biggest demon is actually The West's own way of life – terrorism against nature. It is quite possible that the last of our oil will be used by the American military, fighting

over access to oil. And the last of America's revenue may be used to fund the military instead of to fund solutions to the energy crisis (Global Issues, 2008).

The laws of supply and demand dictate that the rarer a resource is, the higher its price. Since oil and coal are used at the beginning of the production cycles, or even to help extract more ores, their price influences the price producers and consumers pay and therefore the rates of inflation. Consumers respond to this by demanding increased wages or tax cuts, or that the government buffer the price rises. Governments are influenced by the consumers, who are their voters. Ultimately, there is a limit to how much Governments can absorb the costs, as America is finding. This is especially true for a country that spends 50% of its revenue on its military (Global Issues, 2008). If the true cost of the oil wars was factored into the price of oil, America would realize it needs to move on to new energy sources. The synergistic effect of the financial crisis, fluctuating oil prices, climate change impacts and mitigation, consumer goods based on oil and petrol prices and global trade wars, could lead to a world-wide recession or even starvation for many. The political challenges are to maintain as much stability as possible in all arenas and to find ways to become less oil and coal dependant. The greatest challenge is also the simplest: to see all the problems as having the same root cause and similar solutions. Let us now explore the solutions.

## Part 2.

### 2a. **Given that the end of oil or 'peak oil' is a looming reality, explore the viability of alternative sources of energy available, which could replace fossil fuels.**

In his book entitled 'Greenhouse Solutions with Sustainable Energy', Professor Mark Diesendorf demonstrates that it is still possible to replace coal with renewables in Australia. Diesendorf argues that if we start by reducing our electrical waste and increasing the efficiency of all buildings and manufacturing processes, we can save 20% of our CO<sub>2</sub> output. All that is needed, he argues, is the political capacity to implement policy changes at all levels of government, to drive these reductions in wastage. However, Tim Flannery takes a much more skeptical (or perhaps realistic) view, arguing that since we have not acted quickly enough, we now need clean coal technology or nuclear power stations (Flannery, 2008). One gets the impression that he is clutching at straws, for neither of these options could come to fruition in time. Natural Gas is more likely to fulfill this role. This author strongly believes that we should be both reducing waste and inefficiency *and* planting bio-diverse forests whilst we sort out the other issues.

There are 20 different types of renewable energy. Of these, the ones that are both economically viable and most effective for Australia are: passive solar building design, solar hot water, solar space heating, solar industrial heat up to 200 degrees C, photovoltaic electricity and solar thermal electricity; wind energy, bio-electricity, hot dry-rock geothermal, bio-ethanol, bio-methanol and bio-diesel. All of these can be commercially viable in Australia by 2015, with or without tax incentives (Diesendorf, 2007, p78).

Contrary to popular opinion, the embodied energy that is necessary to manufacture and erect huge wind or solar farms is small indeed compared with making a coal fired power station (Diesendorf, 2007). Once the Carbon Emissions Scheme is a reality, these renewable energies will be competitive with coal-fired electricity. Of course, their potential is dwarfed by the

potential of nuclear energy to make electricity but nuclear is not a truly renewable source: we have a finite amount of it. What makes nuclear so unattractive, apart from the risks involved, is the massive cost of building, operating and de-commissioning the power plants. It is the most expensive form of electricity available, with a lag phase of about 20 years before production. An enormous amount of greenhouse gases are emitted during the building phase, due to the cement and steel manufactured and transported to the site (Caldicott, H, 2006).

The potential of biofuels to replace petrol and diesel and even fuel power stations in Australia is double that of European countries (Diesendorf, 2007, p 151). Diesendorf quotes CSIRO studies which show that 30-39% of our electricity production in 2004 could have been provided by biofuels sourced from agricultural residues and oil mallee. This would be done in integrated gasification combined-cycle power plants. We can re-plant all of the degraded and salinity-affected lands with local, native bio-fuel plants. However, biofuel plants must not be allowed to compete with food growing crops for the same land or water, as this would diminish food supplies. Strong regulations are required and we must not follow America's example. Mass plantations of mallee and other native trees for bio-fuels could lead to even more environmental degradation if not properly regulated. The problem is that "there is no shared vision of the benefits of bio-based products and their potential to reduce dependence on imported oil and polymers, reduce green house gas emissions and foster industries" (Rural Industries Research and Development Corporation (RIRDC), 2008). Bio-fuel plantations would cool the surface temperatures, increase evaporation and decrease runoff as well as releasing oxygen and capturing carbon dioxide. According to the RIRDC, second generation bio-fuels have the potential to replace a significant proportion of our transport fuel requirements as they can be sourced from a wide selection of plant and woody materials. There are many technologies that can be applied to second generation bio-fuel production and this is reflected in the broad spectrum of research efforts being undertaken worldwide (RIRDC, 2008). In conclusion, Australia's ability to replace oil-fuels with bio-fuels seems to be expanding significantly, whilst our ability to replace electricity generation is enormous. Let us now examine how the Governments have affected, and are affecting, this transition process.

## **2b. As well, critique measures taken by the government to address this issue - e.g. emissions trading scheme, carbon offsets and carbon credits.**

The most tragic mistake that Australian governments have made (particularly Howard) is not to kick-start the 'renewables' industries years ago. They should have been well established BEFORE threatening to reduce the export earnings of some of our major companies by 32-64% (Greig Gailey, ABC, 27.8.08) with the Emissions Trading Scheme (ETS). That said, a major step in addressing our dependence on fossil fuels and Global Warming was to sign the Kyoto Protocol.

The Rudd Government's *Green Paper* was released in July 2008, outlining the skeleton of its proposed 'cap and trade system' for reducing carbon emissions (Green Paper, 2008). Targeted at our 1000 largest companies, some of which provide our lucrative export income, the system is structured so that each permit (one per tonne of CO<sub>2</sub>) will become a production cost, which will be passed onto the consumer. To compensate for this, the government has made both a politically

and morally correct decision, stating that it will use “every cent raised to assist households and business” (Green Paper, 2008). The government clearly intends to compensate big business so much that there will not be enough money left to help the poor, or invest in purposeful renewables research and development. How long will pension increases and tax concessions last for and what will happen when there is a change back to a Liberal government? Answers to these detailed questions will be available when the White Paper comes out in December 2008.

The proposed solution to carbon emissions has not been linked to Peak Oil at all; in fact fuel excises are to be reduced to encourage more driving! The Green Paper lacks sufficient incentives or legislative proposals to enforce big polluters to invest in renewables. However, they are doing it themselves, turning the ETS to their advantage. Major coal corporations like BHP and Rio Tinto are investing in ‘an array of large-scale solar thermal power plants across Australia’ (Christine Milne, 12.8.2008) whilst simultaneously lobbying the government for as many free carbon permits as possible. Other new companies are emerging and vast wind and solar farms are on the drawing board (Planning, Dept of, 2008), awaiting the Government’s support. The effectiveness of the White Paper at addressing Global Warming and Peak Oil will depend largely upon the amount of financial support given to the renewables industries to help them to seriously enter the market and how little support the big polluters are given. As Christine Milne explains:

*"The exciting vision of a solar power boom across Australia will not happen unless the Rudd Government steps up to the plate with the right incentives, starting with immediately increasing the mandatory renewable energy target and supplementing it with comprehensive renewable energy feed-in tariffs. An emissions trading scheme design which protects existing coal investments, as Rudd and Wong's proposal would do, will not make this completely achievable vision become a reality".*

The BEST way to ‘hospice’ the fossil fuels industries is to help them to earn income through investing in renewables, whilst putting some pressure on them for emissions, without crippling them. The Green Paper does not indicate any intention to force big polluters to invest in renewables, directly. The DANGER for Australia is: how long will the lag phase between the new and old industries be? Hopefully Natural Gas will be utilized as the intermediate form of fuel. The Green Paper’s cap on the price of carbon from 2010-2015, and the 30% free permits to the big polluters are designed to give us time to make the transition; though many, including the author, believe it is much too large and for too long (Get Up, 16.07.08). It is critical that Rudd gets the balance right in the December White Paper. Eventually we will have to align with the world market price on carbon, under international obligations and to level the playing field.

It is a very complex issue: our export revenue is tied to our superannuation packages; the jobs of 924 000 Australian workers (Greig Gailey, 2008) and global jobs, like those of Chinese factory workers, are at risk. Auctioning the permits is going to mean drastic increases to our power bills, aluminum products, steel frameworks, houses etc as the permits will go to the highest bidder – the most resilient private corporations. According to Greig Gailey, It will create investment uncertainty and will push investment offshore to the Developing countries that don’t have emissions schemes. This would relocate CO<sub>2</sub> emissions (which won’t help global warming) at a high social cost to Australia.

*"Instead of frittering away ETS revenue on protecting the coal sector, we should be investing those funds in the infrastructure and training that we will need in order to make the transition to a zero carbon energy grid"* (Christine Milne, 12/8/08).

The Green Paper does not indicate enough of a 'solutions' focused attitude, or an integration of the Climate Change and Peak Oil issues.

The Carbon credits/offsets schemes can at best provide a 50% cut in emissions. They are set up to offset emissions, not to eradicate them. This is just economic and administrative juggling. It is unacceptable to design a carbon offsets/credits scheme which allows forestry to trade off planting monocultures for cutting down old growth forests, or which allows Councils to trade waste management credits for diesel fuel for their heavy machinery. Increases in efficiency (eg composting or recycling plants, light bulbs etc) should not be tradable at all. To create a carbon-neutral event by having trees planted to offset the carbon costs of the event is at least better than no trees at all. But it is a very neo-liberal response to an environmental problem. It is just subsidizing someone else to plant mono-cultures of harvestable trees, for short-term future profit. We need to plant permanent, mixed-species original native forests on cleared land that needs re-covering. Our lives and our environment should not be a political and economic gamble.

## **2c. Explain the political and economic issues that may impede the necessary transition to an economy not dependent on fossil fuels as the main source of energy.**

The Government is presently using the financial crisis to hesitate in their commitment to the emissions trading scheme, even though Garnaut says "now is the best time" (ABC News Online, 2384749.htm). According to Garnaut, "Financial crisis is not an easy time politically to make major long-term structural reforms but it's actually the right time economically". Garnaut, however, has recommended lowering the government's emissions target to 10% of 2000 levels by 2020 (Bob Brown, 2008). By far the largest hindrance to reducing greenhouse gases is that the American and Australian Governments have not envisaged a package to solve all of the global crises together. A huge shift to renewables would boost the economy and employment, reduce emissions and reduce oil and coal dependency.

A large political impediment to a change-over to renewables in Australia is the lack of appropriate policy at all levels of government. We desperately need to raise the Mandatory Renewable Energy Target to over 20%, with a short lag phase (2 years). This will drive investment in wind, solar etc and allow all those potential wind farms that are sitting on the Department of Planning's desks to be built. Urban planning and transport infrastructure planning need to be integrated. We need money to fund this new infrastructure; if the government gives 30% of the permits away for free there will not be enough money to re-organize our cities (Get Up, 16.07.08). Government subsidies to the minerals and oil industries impede the ability of renewables to compete in the neo-liberal market place. Donations to political campaigns from vested interests undermine the government's independence (Greens, 2008).

On an international level, the economic ideal would be for all countries to introduce similar emissions trading schemes (or tax schemes) simultaneously, with the same price on carbon emissions, but this is not realistic. It is perceived that helping the Developing countries would

undermine our own economic advantage. This is why Bush refused to sign Kyoto. However, sharing our latest technologies, our environmental regulation processes (eg Environmental Impact Assessments; policies & laws ) and our expertise with developing countries would keep their emissions levels and their oil and coal dependencies as low as possible whilst their standard of living improves; and also create new trade partners for us. Governments and industry need the courage and the cooperative attitude to share our newest technologies with the most inefficient countries. This is most unlikely to occur in a neo-conservative paradigm where nations are competing over oil instead of being solution-focused.

On the positive side, there is an incentive: as a Kyoto nation, we will pay substantial carbon penalties for each year that we overshoot our carbon budget. Our debt to the environment is being called in. As citizens of a Democracy, we can speak up and influence the government of the day through various means.

### Part 3.

**In order to avert the disasters predicted as consequences of climate change, we the people, our governments and business need to do more than pay mere lip-service to ending the reliance on fossil fuels and be committed to substantially reducing greenhouse gas emissions NOW. In other words we cannot continue with a 'business as usual' approach and an associated 'political economy as usual' approach if we are to successfully tackle the problems associated with climate change.**

#### 3a. Therefore, what actions can we take to lobby our governments to act decisively now?

Lobbying to Governments is often best done through organizations, as these generally have more power than an individual. Below are listed some of the actions we can take to lobby governments to proactively deal with Global Warming and Peak Oil:

- Join a political party that pushes for solution-focused policies and laws
- Write to State and Federal ministers and local council members
- Respond to the Green Paper and other papers when submissions are open (individually or as a group)
- Join rallies and protest marches like Walk Against Warming
- Join and fund activist groups, like Get Up, CANA and ACF, and sign their petitions
- Use the media, arts and theatre as much as possible to get the message across.

Activist groups can lobby our governments to:

- Increase the mandatory renewable energy targets
- Increase the 2020 emissions targets
- Stop investment in building coal-fired power stations
- Increase funding for renewables research
- Increase funding for community-environmental educators
- Make it mandatory to retrofit and upgrade rental properties and older houses
- Upgrade urban transport systems and
- Upgrade the BASIX regulations

### **3b. What direct actions can we take as citizens to facilitate the necessary transition to using alternative sources of fuel as a means of rapidly reducing greenhouse gas emissions –to avert impending disasters and move to a carbon neutral economy?**

As individuals there are many things we can do that, collectively, make a difference. Most of all, they tell the governments that we are prepared to adapt. We can:

- Join a political party that pushes for solution-focused policies and laws
- Stop voting for parties that think war is a solution or that receive funding from big polluters
- Learn to use the preferential voting system properly
- Join environmental and community lobbying and educational groups -local and national
- Talk about the issues to everyone we can
- Do a green-audit of our business environment and take action to improve efficiency
- Buy Green Power and buy Australian products
- Educate ourselves about solar, wind, bio-fuels, nuclear, vegetable growing etc
- Implement the waste management hierarch in our daily lives – reduce, reuse, recycle; repair instead of replace. This can mean buying a second hand TV instead of a new plasma TV, selling the drinks fridge, repairing an old chair
- Take public transport or car pool; buy an efficient, small car
- Avoid flying; take the train instead; holiday closer to home
- Live close to public transport
- Improve energy efficiency of household appliances like light bulbs, fridges etc
- Reduce electricity use – turn off at power points
- Insulate the roof; Install solar hot water heaters
- Start a community vegetable garden; Buy locally grown, organic produce
- Avoid buying energy-intensive products like aluminium, or toxic plastics
- Join a Landcare group and plant many trees; eat further down the food chain
- If necessary, change jobs to do something less destructive, or solution-focused
- Save more money and borrow less and
- Be a social, ethical and environmental investor.

## **Conclusion**

The time bomb of Global Warming is ticking away and we must prepare ourselves for temperature rises that we cannot avoid. However, we must act immediately to avert intolerable temperatures and natural disasters. It is time to evolve past the fossil fuels era. Hopefully, one day we will be able to look back into history and recall the age of coal and oil and joke about how primitive it was. If we can make wise choices to stabilise our population, share our technological advances and drive the renewables revolution, we may survive this crisis. However, if Governments cannot enforce enough regulatory control over the highly polluting neo-liberal multinationals, to cut CO<sub>2</sub> emissions to 1990's levels, the future looks bleak indeed. The greatest obstacles to overcome are the American Government's investment in military aggression and high-emissions activities (Daadler, 2007); the funding of governments by the

worst polluters and the short election terms (though this may be a blessing until a Green party dominates). These three things must be de-coupled and people-power, through demonstrating, campaigning and voting, is a major step in achieving this; providing people have the education to understand what is at stake. The other major driving force is solution-focused big-business, investing in our future. Let us hope that the market-opportunities themselves, and people's commonsense, will lead the governments down the right path.

## References

- ABC News Online, 18/10/08, *Global financial crisis: emissions scheme will stimulate economy: Garnaut*, accessed online on 23/10/08 at [www.abc.net.au/news/stories/2008/10/18/2394749.htm](http://www.abc.net.au/news/stories/2008/10/18/2394749.htm)
- Brown, R., 5/7/2008, Press Release: Garnaut's weak targets recipe for catastrophic climate change – Greens, accessed online on 13/10/08 at <http://bob-brown.greensmps.org.au/taxonomy/term/63/all>
- Caldicott. H., 2006, *Nuclear Power is Not the Answer to Global Warming or Anything Else*, Melbourne University Press.
- Daalder. I. & Kagen. R., 2007, *Bridging the Foreign Policy Divide: America and the use of force: sources of Legitimacy*, in The Stanley Foundation newsletter, accessed online on 8/8/08 at <http://www.stanleyfoundation.org/publications/other/DaalderKagan07.pdf>
- Diesendorf. M., 2007, *Greenhouse Solutions with Sustainable Energy*, UNSW Press, Sydney.
- Gailey, G, 2008, ABC News Online, Opinion, “*Emission cuts: showing the world it can be done*”, accessed online on 20/10/08 at [www.abc.net.au/news/stories/2008/08/27/2347975.htm](http://www.abc.net.au/news/stories/2008/08/27/2347975.htm)
- GetUp, Press Release: *Omissions Trading Scheme*, 16.07.08. accessed online on 15.10.08 at [www.getup.org](http://www.getup.org)
- Global Issues, 2008, *world military spending*, accessed online on 3/9/08 at [www.globalissues.org/article/75/world-military-spending](http://www.globalissues.org/article/75/world-military-spending)
- Green Paper, July 2008, Australian Government, Dept of Climate Change, accessed online on 12/10/08 at <http://www.climatechange.gov.au/greenpaper/index.html>
- Milne, Senator Christine, 2008, *Press Release 12/08/2008: Emissions Trading Scheme*, accessed online on 15/10/08 at <http://greens.org.au/node/1887>
- Nichols. D., 19/7/08, Green Left Online, *Rudd's Green Paper: Higher Carbon Emissions*, accessed online on 26/10/08 at <http://www.greenleft.org.au/2008/759/39236>
- People and Planet, 2008, *Sweden Plans to be the World's First Oil-free Economy*, accessed online on 2/9/08 at [www.peopleandplanet.net/doc.php?id=2662](http://www.peopleandplanet.net/doc.php?id=2662)
- Planning, Dept of, NSW Government, Major Project Assessments, accessed online on 24/10/08 at [http://www.planning.nsw.gov.au/asp/major\\_projects.asp](http://www.planning.nsw.gov.au/asp/major_projects.asp)
- Rural Industries Research and Development Corporation, accessed online on 20/10/08 at [www.rirdc.gov.au/](http://www.rirdc.gov.au/)
- SAHFOS, 2008, Sir Alistair Hardy Foundation for Ocean Science, accessed online at <http://www.sahfos.ac.uk/Climate%20Encyclopaedia/index2.html>