Chapter 7 Decoupling Economic Growth from Greenhouse Gas Emissions to Achieve Environmental Sustainability.

Introduction: (Rationale and Outline of the Chapter)

The discussion in Chapter 6 has shown that there is now a significant body of empirical evidence which shows that many of the social justice goals encapsulated in the Earth Charter correlate with improved economic prosperity. The evidence assembled in Chapter 6 suggests that higher economic growth of developing nations correlates with effective investment in health, education, poverty reduction and family planning. Chapter 6 showed that achieving basic standards in health and education, poverty reduction, stabilising population growth and reducing corruption have assisted, and certainly not harmed, the creation of sustained quality economic growth.

However, in achieving the social justice goals of the Earth Charter and eliminating poverty this will create an additional 2-3 billion people aspiring to consume just as much as is currently consumed unsustainably in OECD countries. As discussed in Chapter 1, it is physically impossible for all developing nations to achieve Western material living standards with previous modes of development, as the global 'ecological footprint' (the equivalent land and water area required to produce a given population's material standard, including resources appropriated from other places) is already greater than the carrying capacity of our planet.[1] The 2002 UNEP Sustainable Consumption Global Status Report, put the predicament starkly stating that

> "If China were to consume seafood at the per capita rate of Japan, it would need 100 million tonnes, more than today's total catch. If China's beef consumption was to match the USA's per capita consumption and if that beef was produced mainly in feedlot, this would take grain equivalent to the entire US harvest."[2]

If we also assume that the Chinese will spend their income more or less as Americans do today, then we can translate their income into consumption. As Lester Brown explains

> "If, for example, each person in China consumes paper at the current American rate, then in 2030 China's 1.46 billion people will need twice as much paper as is produced worldwide today. If we assume that in 2030 there are three cars for every four people in China, as there now are in the United States, China will have 1.1 billion cars. The world currently has 860 million cars. To provide the needed roads, highways, and parking lots, China would have to pave an area comparable to what it now plants in rice.

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[1] World Wildlife Fund (2004) *Living Planet Report*. WWF. Available at www.panda.org/news_facts/publications/key_publications/living_planet_report/index.cfm Accessed 8.01.2008

[2] UNEP (2002*) Sustainable Consumption: Global Status Report 2002*, UNEP, Paris (report written by Professor Chris Ryan, RMIT University, Melbourne, Australia, and the International Institute for Industrial Environmental Economics (IIIEE), Lund University, Sweden)

> By 2030 China would need 98 million barrels of oil a day. The world is currently producing 85 million barrels a day and experts from the International Energy Agency have warned in 2007 that we may never produce much more than that."[3]

What China and India's economic growth is reminding us is that the western first industrial revolution model - the fossil-fuel-based, automobile-centered, highly waste producing—is not physically sustainable on a global scale.

Eliminating poverty and raising living standards globally could also significantly increase demand for renewable and non-renewable resources, increase the risks of rising pollution levels and global climate change. Whilst the reduction in poverty in India and China is a great achievement, it is currently coupled with rising demand for all resources. Of all the world's nations, today China is the largest consumer of resources. [4]

Global demand for oil is outstripping supply and increasing the price of oil which rebounds to hit the poor the hardest. Already food commodity prices globally have risen due to the perfect storm of climate change and drought, increased demand for grain fed food, urbanisation reducing available farmland, plus a shift of agricultural land to biofuels. The poorest of the world, who spend 80-90 percent of their incomes on food, are being priced out of the market.[5]

Already, a quarter of the world's armed conflicts of recent years have involved a struggle for natural resources. Security experts warn that rising demand for non-renewable and renewable resources such as oil, minerals and water respectively could increase the number of resource wars this century.[6] The Stern Review warned that climate change would reduce the availability of water to significant proportion of the world potentially setting of water wars. The Stern review stated

> "Drought and other climate-related shocks risk sparking conflict and violence, with West Africa and the Nile Basin particularly vulnerable given their high water interdependence."[7]

Climate change is but one environmental pressure which, if not addressed, has the potential to undermine global efforts to achieve the social justice goals of the Earth Charter. As the Stern Review stated:

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[3] Brown, L (2008) *Plan B. Mobilising to Save Civilisation*. The Earth Policy Institute. p13. Available At http://www.earth-policy.org/Books/PB3/Contents.htm Accessed 17.02.2008

[4] BBC (2006) *China emerges as global consumer*. BBC News Available at http://news.bbc.co.uk/2/hi/asia-pacific/4272577.stm Accessed 17.02.2008

[5] Garber, K (2008) *The Growing Food Cost Crisis: Sharp Price hikes are Hurting the Poor and Sparking Violence*. US News. Available at http://www.usnews.com/articles/news/2008/03/07/the-growing-food-cost-crisis.html Accessed 17.03.2008

[6] Klare, M. (2001) *Resource Wars.The New Landscape of Global Conflict*. New York: Metropolitan Books.

[7] Stern, N *et al.* (2006) *The Stern Review: The Economics of Climate Change*, Cambridge University Press, Cambridge.p104 Available at www.hmtreasury.gov.uk/independent_reviews/stern_review_economics_climate_change/Sternreview.index.cfm Accessed 14 April 2007

> "Climate change poses a real threat to the developing world. Unchecked it will become a major obstacle to continued poverty reduction. Developing countries are especially vulnerable to climate change because of their geographic exposure, low incomes, and greater reliance on climate sensitive sectors such as agriculture. For low-income countries, major natural disasters today can cost an average of 5% of GDP. Health and agricultural incomes will be under particular threat from climate change. Millions of people will potentially be at risk of climate-driven heat stress, flooding, malnutrition, water related disease and vector borne diseases. Up to an additional 145-220 million people could be living on less than $2 a day and there could be an additional 165,000 to 250,000 child deaths per year in South Asia and sub-Saharan Africa by 2100 (due to income losses alone)."[8]

Chapters 3 and 4 of the Stern Review expand on this and outline in detail the devastating ways that climate change will further undermine efforts to achieve poverty reduction as was discussed in detail in Chapter 6 of this thesis. Thus environmental protection and sustainable use of resources will be needed to ensure that poverty reduction is able to be sustained long term. But this challenge of achieving simultaneously the reduction in poverty, a rapid transition to environmental sustainability whilst maintaining strong economic growth to enable the required investment to be possible will not be easy. This chapter, and the following Chapter 8, cover strategies which enable the developing world to leapfrog the OECD to become ecologically sustainable economies. This chapter and chapter 8 outline options and strategies which provide all nations with an opportunity to make a rapid shift to ecologically sustainable development to try to prevent planetary ecosystems losing significant resilience by passing irreversible ecosystem thresholds and tipping points.

Chapter 1 outlined a range of environmental pressures - greenhouse gas emissions, urbanisation and sprawl, loss of biodiversity and loss of species, drought and loss of freshwater availability, soil degradation, over-consumption of resources and production of waste, air, land and water pollution, and toxic chemicals.

This chapter investigates environmental pressures from rising greenhouse gas emissions and discusses potential costs and benefits of making the necessary investments to decouple economic growth from greenhouse gas emissions on a global scale.

Chapter 8, which follows, looks at the other main sources of environmental pressure and investigates the costs and benefits of decoupling economic growth from environmental pressures.

This chapter first considers greenhouse gas emissions, of all theses environmental pressures, for three main reasons.

First, as the OECD has argued mitigating climate change is the most important of all environmental challenges because if humanity does not succeed climate change will undermine and make far worse

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[8] Ibid. p104-105

all other environmental and social problems. According to the OECD's Secretary General, Angel Gurria:

> "Climate change is mankind's most important challenge…In two decades, unchecked (climate change induced) environmental damage could leave half the world's population without adequate drinking water."[9]

Climate change from greenhouse gas emissions will result in greater intensity of natural disasters, a decline in water availability, loss of biodiversity both on land and in the ocean due to ocean acidification and rising sea temperatures bleaching coral reefs. As Lester Brown wrote:

> "Efforts to save wildlife traditionally have centred on the creation of parks or wildlife reserves. Unfortunately, this approach may now be less effective, for if we cannot stabilize climate, there is not an ecosystem on earth that we can save. Everything will change. In the new world we are entering, protecting the diversity of life on earth is no longer simply a matter of setting aside tracts of land, fencing them off, and calling them parks and preserves. Success in this effort depends also on stabilizing both climate and population."[10]

Since greenhouse gas emissions are a significant environmental pressure strongly coupled with other environmental pressures, economic growth must be decoupled from greenhouse gas emissions as part of any serious strategy to reduce environmental pressures overall.

Secondly, many of the actions required to decouple economic growth from greenhouse gas emissions will also simultaneously decouple economic growth from other environmental pressures and help achieve overall sustainable development.

- Mitigating climate change will require the world to reduce rapidly its dependency on oil, coal and gas thus reducing dependency on non-renewable resources. Similarly the mining and processing of non-renewable mineral and petrochemical resources is highly energy intensive compared to metal and plastics recycling. Thus efforts to mitigate climate change will lead to a transition to higher levels of metal and plastics recycling.
- Mitigating climate change successfully will involve reducing waste to landfill to prevent methane emissions. This will have the effect of encouraging recycling of all materials thus helping to reduce over-consumption of resources. This will help to reduce environmental pressures from increasing material flows and waste streams globally.

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[9] Mellgren, D. (2008) *OECD issues warning on climate change action or else half the world will suffer*. The Associated Press. Available at http://indpress.wordpress.com/2008/03/05/oecd-issues-warning-on-climate-change-action-or-else-half-the-world-will-suffer/

[10] Brown, L (2008) *Plan B. Mobilising to Save Civilisation*. The Earth Policy Institute. p13. Available At http://www.earth-policy.org/Books/PB3/Contents.htm Accessed 17.02.2008

- Addressing climate change will also require the world to transform its resource dependant cities into sustainable cities. Cities are currently responsible for over 60 per cent of all global greenhouse gas emissions. Better urban design will be crucial elements of any holistic strategy to decouple economic growth from transport greenhouse emissions. But actions to do this will also reduce other environmental pressures such as air pollution. As the 2008 OECD Environmental Outlook for 2030 stated "Cutting motor vehicles' greenhouse gas emissions would improve air quality in cities."[11]

Urban air pollution is a serious problem in the cities of many developing and fast growing economies. The health costs from urban pollution and poor urban and building design are significant. There are clear opportunities for simultaneously improving health and cutting GHG emissions most obviously through policies related to transport systems, urban planning, building regulations and household energy supply. These influence some of the largest current global health burdens, including approximately 800,000 annual deaths from ambient urban air pollution, 1.2 million from road-traffic accidents, 1.9 million from physical inactivity, and 1.5 million per year from indoor air pollution.[12] The fact that actions to reduce greenhouse gas emissions will also reduce these tragic statistics and reduce by 100s of billions projected health costs this century is seen by many developing country governments as a key reason to support action to mitigate climate change.

One of the most cost effective ways to mitigate climate change would be for the OECD countries to pay developing countries a fair price to reduce rapidly deforestation and farm soil losses to better maintain their forests and soils as carbon stores. This provides renewed impetus for the OECD helping their own farm and forestry sectors as well as those in developing countries to shift to genuinely sustainable management of forests and soils. As The Stern Review states

> "A study commissioned for the Review looking at 8 countries responsible for 70 per cent of emissions from deforestation found that…emission savings from avoided deforestation could yield reductions in CO_2 emissions for under \$5/t CO_2, and possibly for as little as \$1/t CO_2." [13]

If done, this will have significantly positive biodiversity benefits as most of the world's species are found in the world's rainforests and forests. Countries like Indonesia would benefit from this approach. Indonesia has two of the world's biodiversity hotspots and is the second most mega-diverse nation after Brazil.

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[11] Mellgren, D. (2008) *OECD issues warning on climate change action or else half the world will suffer*. The Associated Press. Available at http://indpress.wordpress.com/2008/03/05/oecd-issues-warning-on-climate-change-action-or-else-half-the-world-will-suffer/

[12] Campbell-Lendrum, D. Corvalán, C. (2007) *Climate Change and Developing-Country Cities: Implications For Environmental Health and Equity*. J Urban Health. 2007 May; 84(Suppl 1): 109–117. Available at http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1891643

[13] Stern, N. (2006) *The Stern Review: The Economics of Climate Change, Chapter 9 Identifying the Costs of Mitigation. Cambridge University Press*, Cambridge. pp244-247 Available at http://www.hm-treasury.gov.uk/media/F/0/Chapter_9_Identifying_the_Costs_of_Mitigation.pdf

The OECD's 2030 Environmental Outlook points out other less obvious environmental pressures which will be reduced from strong action on climate change stating that:

> "Ambitious climate change policies (to achieve 450ppm stabilisation) would also lead to reductions in sulphur oxides of 20-30% and in nitrogen oxides of 30-40% by 2030. Similarly, regulations to limit agricultural water pollution from nitrogen fertilisers can also reduce atmospheric emission of nitrous oxide, a potent greenhouse gas."

Thus, if it is possible to demonstrate that environmentally sustainable cuts to greenhouse gas emissions can be achieved whilst maintaining strong economic and jobs growth this result also holds for a significant portion of what is needed to achieve environmental sustainability.

Thirdly, focusing first on decoupling economic growth from greenhouse gas emissions enables us to reinforce the earlier (Chapter 1, 2 and 5) discussion of negative rebound effects. Rebound effects, if not managed with good policy can undermine energy, water and materials efficiency gains. If not properly managed with good policy negative rebound effects can significantly undermine efforts to mitigate climate change through energy and fuel efficiency improvements. This chapter re-inforces the main message of the thesis concerning rebound effects: that to avoid negative rebound effects policy, regulation, information and incentives are needed to ensure that the profits made from energy, water and materials efficiency do not multiply into more unsustainable consumption patterns but instead are redirected and invested in further sustainability initiatives such as investment in renewable energy and carbon offsets which also protect biodiversity. Effective policy is needed to do this. Due to word limit restrictions this chapter is unable to cover a discussion in detail of policy options. But policy issues are listed in Appendices 7.3-7.5. Appendix 7.3 of this chapter provides an overview of leadership on climate change policy globally. Appendix 7.4 overviews existing Australian climate change policy and programs which can be built upon, and Appendix 7.5 outlines briefly a range of policy options needed to provide the best chance of achieving the necessary levels of decoupling.

7.1 An Historic Challenge - Decoupling Economic Growth from Greenhouse Gas Emissions Fast Enough to Achieve Environmental Sustainability.

Decoupling economic growth from greenhouse gas emissions fast enough on a global scale is one of the hardest challenges humanity has ever faced because of a number of factors:

First, the scale and speed of change needed to the global economy to avoid dangerous climate change, and achieve stabilisation of greenhouse gas levels. A number of climate scientists and policy analysts are advising that developed nations must make GHG emission cuts of at least 30 per cent relative to 1990 levels by 2020, in order to ensure an effective 2050 global target is achieved.[14] The Stern Review

[14] Elzen, D. (2005) Countries' climate mitigation commitments under the 'South-North Dialogue' Proposal. A quantitative analysis using the FAIR 2.1 World Model, Netherlands Environmental Assessment Agency, pp. 59 & 60.

has explained clearly the economic and environmental sustainability imperative of ensuring global greenhouse gas emissions peak, and start reducing as soon as possible. The sooner global greenhouse gas emissions peak, the less stringent annual reductions will need to be thereafter to meet future targets. (See Figure 7.2 and Table 7.1

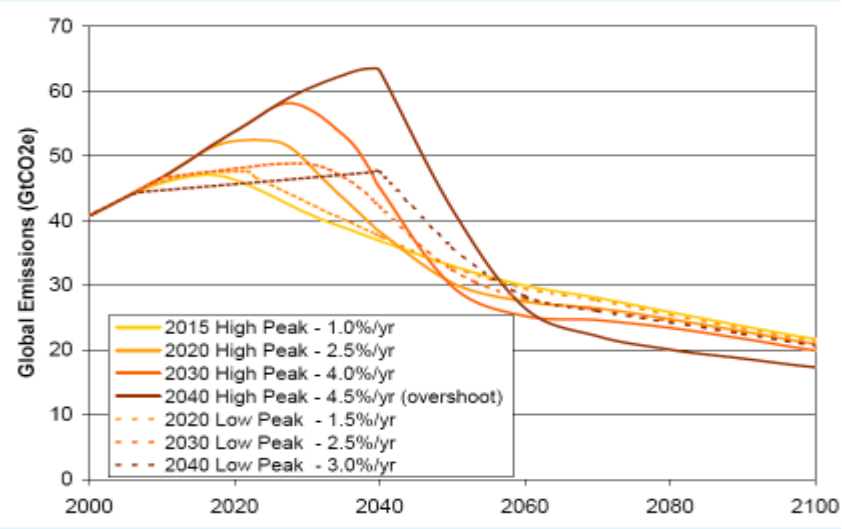

Figure 7.1: Illustrative emissions paths to stabilise at 550 ppm CO2e. The figure shows that delaying emissions cuts (shifting the peak to the right) means that emissions must be reduced more rapidly to achieve the same stabilization goal. (Source: Stern Review (2006)[15])

Table 7.1 Illustrative Emissions Paths to Stabilisation (Source:Stern Review(2006[16]))

Stabilisation Level (CO_2e)	Date of peak global emissions	Global emissions reduction rate (% per year)	Percentage reduction in emissions below 2005* values	
			2050	2100
450 ppm	2010	7.0	70	75
	2020	-	-	-
500 ppm (falling to 450 ppm in 2150)	2010	3.0	50	75
	2020	4.0 - 6.0	60 - 70	75
	2030	*5.0[1] – 5.5 [2]*	*50 - 60*	*75 – 80*
	2040	-	-	-
550 ppm	2015	1.0	25	50
	2020	1.5 – 2.5	25 – 30	50 – 55
	2030	2.5 – 4.0	25 – 30	50 – 55
	2040	3.0 – *4.5 [3]*	*5* – 15	50 – *60*

Table 7.1 shows the sensitivity of rates of emissions reductions to the stabilisation level and timing and size of the peak in global emissions. The table covers three stabilisation levels and a range of

[15] Stern, N. (2006) *The Stern Review: The Economics of Climate Change, Chapter 9 Identifying the Costs of Mitigation.* Cambridge University Press, Cambridge. Pp226 Available at http://www.hm-treasury.gov.uk/media/F/0/Chapter_9_Identifying_the_Costs_of_Mitigation.pdf

[16] Ibid. p227

peak emissions dates from 2010 to 2040. The centre column shows the implied rate of global emissions reductions.

Table 7.1 shows that the challenge of stabilization is significant. If the positive feedbacks, outlined above, are unleashed significantly further, it will make stabilization very hard to achieve. The IPCC is calling for global greenhouse gas emissions to peak by 2014-15 to minimize the risk of the positive feedbacks being unleashed. The Stern Review states that

> "In the long term, global emissions will need to be reduced to less than 5 GtCO2e, over 80% below current annual emissions, to maintain stabilisation. The longer emissions remain above the level of natural absorption, the higher the final stabilisation level will be. Stabilisation cannot be achieved without global action to reduce emissions. Early action to stabilise this stock at a relatively low level will avoid the risk and cost of bigger cuts later. The longer action is delayed, the harder it will become. Delaying the peak in global emissions from 2020 to 2030 would almost double the rate of reduction needed to stabilise at 550 ppm CO2e. A further ten-year delay could make stabilisation at 550 ppm CO2e impractical, unless early actions were taken to dramatically slow the growth in emissions prior to the peak. To stabilise at 450 ppm CO2e, without overshooting, global emissions would need to peak in the next 10 years and then fall at more than 5% per year, reaching 70% below current levels by 2050."[17]

Few countries have ever achieved more than one per cent greenhouse gas reductions per annum. Hence achieving at least five per cent reductions in GHG emissions per annum reductions in greenhouse gas emissions in every country globally simultaneously is an historic challenge.

Since the Stern Review was published in 2006, global CO2e emissions are tracking higher than Stern predicted and have even exceeded the IPCC's worst case scenario's. Since the Stern Review was published, higher economic growth than predicted in China and India is seen to have caused greenhouse gas emissions to be higher than predicted in 2008. As the Garnaut Review Interim report explains:

> "Global economic growth, the energy intensity of growth, and the carbon intensity of energy in the early twenty first century have all been exceeding expectations that had been built into the most influential assessments of climate change…Over recent years, average annual global economic growth has been around five per cent (using purchasing power parities (PPPs), as one should, rather than market exchange rates (MERs)). This is much higher than in the last quarter of the twentieth century. This accelerated expansion has been led by growth rates of ten to twelve per cent in China and eight to nine

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[17] Stern, N. (2006) *The Stern Review: The Economics of Climate Change, Chapter 8: The Challenge of Stabilisation*. Cambridge University Press, Cambridge, p10. Available at. http://www.hm-treasury.gov.uk/media/8AC/F7/Executive_Summary.pdf. Accessed 13. February 2008

> per cent in India. The evidence is accumulating that these high average growth rates of the early twenty-first century are not temporary phenomena."[18]

Also in the last 2 years, since the Stern Review was published, there has been evidence published which shows that global warming is accelerating under the action of several amplification/positive feedback processes that was summarized in Chapter 1 of the thesis.[19] As noted in Chapter 1, these predictions of the Stern Review were taken without taking into account the historic summer Arctic ice melt in the summer of 2007. As a result of these developments the Australian and State Government's Garnaut Review's Interim report[20], other experts[21], Australian State Premiers and the mainstream media[22] have acknowledged that the assumptions about the potential rates of greenhouse gas emission used in the scenario's that Stern and the IPCC based their conclusions upon are already out of date. Garnaut said to The Age newspaper:

> "Major reports of recent years, including the UN Intergovernmental Panel assessments and the Stern report, have used scenarios that are already out of date."[23]

As the Garnaut Review's interim report stated:

> "The Stern Review estimated that to keep below 450 ppm at all times would require sustained annual reductions of seven per cent. Recent acceleration of global emissions growth has made the task even harder than anticipated just two years ago.
>
> Developments in mainstream scientific opinion on the relationship between emissions accumulations and climate outcomes, and the Review's own work on future "business a usual" global emissions, suggest that the world is moving towards high risks of dangerous climate change more rapidly than has generally been understood. This makes mitigation more urgent and more costly. At the same time, it makes the probable effects of unmitigated climate change more costly, for Australia and for the world."[24]

Hence the level of decoupling required quickly to avoid high risks of dangerous climate change and achieve environmental sustainability across all sectors simultaneously and globally will take an even more serious and concerted effort. The Garnaut Review Interim Report incorporated this into its new modelling that suggests that to achieve a global stabilization of 450 ppm or 550ppm will require even tougher short term and long term targets to be met.

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[18] See Garnaut Review Interim Report at http://www.garnautreview.org.au/CA25734E0016A131/pages/reports-and-papers

[19] Sutton, P. Spratt, D (2008) *Climate 'code red': The case for a sustainability emergency*. Available at http://www.climatecodered.net/ Accessed 7 March 2008

[20] See Garnaut Review Interim Report at http://www.garnautreview.org.au/CA25734E0016A131/pages/reports-and-papers

[21] Sutton, P. Spratt, D (2008) *Climate 'code red': The case for a sustainability emergency*. Available at http://www.climatecodered.net/ Accessed 7 March 2008

[22] Debelle, P. (2008) *Dire New Warning on Climate*. The Age. Available at http://www.theage.com.au/news/national/dire-new-climate-warning/2008/02/20/1203467189745.html

[23] Ibid.

[24] See Garnaut Review Interim Report at http://www.garnautreview.org.au/CA25734E0016A131/pages/reports-and-papers

Secondly, for most of the last century energy usage and greenhouse gas emissions have been strongly coupled with GDP economic growth.[25] Decoupling economic growth from greenhouse gas emissions is harder than achieving decoupling of most other pollutants and environmental pressures because modern economies have been built upon energy from cheap fossil fuels. There is over 100 years worth of infrastructure and industry development based on the use of cheap fossil fuels as a resource. At present, fossil fuels provide 80% of global energy requirements.[26] In addition, greenhouse gas emissions arise from virtually all sectors of the economy in different ways. Unlike acid rain from sulphur dioxide pollution, which was relatively easy to fix technically in coal fired power stations, almost all activities in the economy contribute to creating greenhouse gas emissions, hence there is no one technical fix which can solve the climate change challenge. Rather a more sophisticated portfolio approach of strategies will be needed including at least a transition to greater demand management, energy efficiency, low carbon technologies and energy supply systems, sustainable transport, and carbon sequestration within an effective global and national policy framework.

Thirdly, mitigating and adapting to climate change requires unprecedented global co-operation and agreement. No one country can solve this problem. Global action on climate change suffers from free rider issues. Virtually every aspect of the economy is producing greenhouse gas emissions through its economic activity and thus needs to reduce emissions. This means that a whole of economy approach is needed or else positive achievements in parts of the economy of one nation will be swamped by greenhouse gas emission growth in another part of the economy. Developing countries are understandably concerned about the fairness of any potential cuts they are going to be asked to make under a post Kyoto framework. Also efforts to stop deforestation and create carbon stores in developing countries will be extremely challenging due to current levels of corruption in many timber exporting developing countries.

Fourthly, the challenge of decoupling economic growth from greenhouse gas emissions is also due to the fact that it has to be addressed at multiple scales and in different ways due to the complex nature of the problem. In many OECD countries at least 20% of greenhouse gas emissions result from the cumulative effect of our personal choices of how we use energy in the home and our daily personal transport choices. The projected increases in emissions from personal air travel threaten to swamp whatever improvements people make in other parts of their lives. Hence decoupling economic growth from greenhouse gas emissions is not a problem we can entirely leave to international UN meetings and the policy experts to solve. Rather it will require the concerted efforts of all citizens to take responsibility to reduce their own carbon footprint. This requires additional policies and incentives to specifically address this individual and household scale of greenhouse gas emissions.

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[25] Gioretti, A (2008*) A Discussion on Decoupling of Economic Growth from the Emissions of Carbon Dioxide*. Commissioned for the Parliamentary Commissioner of Environment, New Zealand. Available at http://www.pce.govt.nz/projects/carbon_dioxide.pdf

[26] Schneider,S. Azar, C (2002) *Are the Costs of Stabilising the Atmosphere Prohibitive*? Ecological Economics 42:73-80.

Fifthly, since some corporations produce or use significant amounts of fossil fuel energy they and their workers have feared that action on climate change would reduce their business competitiveness and profit margins and lead to loss of jobs. This has led to significant vested interests forming blocking coalitions to prevent action on climate change since the early 1990s. By 1990, some industries had concluded that greenhouse action would hurt them.[27] They (helped by some misinterpretation of economic modelling results and ill-informed media) convinced many in business and in conservative governments that the economy will be hurt by almost any form of comprehensive greenhouse response. Many economic policy advisors in governments have generally accepted and promoted this view. Beliefs that a response to climate change will hurt the economy are based on misinterpretations of economic modelling. These misinterpretations however cannot be ignored as they have resonated with the general public and with political and business leaders due to common prejudice that that helping the environment must hurt the economy. This chapter seeks to resolve this tension.

- Hence the first part of this chapter shows how some have mis-interpreted economic modelling about the costs and benefits of action on climate change and how the vested interests have used this for their own interests.
- The second part of this chapter discusses ten major strategies to decouple economic growth from greenhouse gas emissions for OECD and developing countries. The second part of this chapter looks at how assumptions by economic modellers about the cost and benefits of these ten strategies significantly affect the results of their modelling.

This thesis recognises that rational discussions about the economic impacts of a wise approach to action on climate change is not going to be sufficient to address the barriers to progress on action to mitigate climate change because of vested interests and blocking coalitions. As Diesendorf writes:

> "Greenhouse solutions demand major social change that is in the common interest of the vast majority of citizens, but runs against the vested interests of powerful organisations. Such changes cannot be achieved simply by convincing government decision makers or the best interests themselves by rational argument. While continuing dialogue is essential, most politicians and other powerful interests will only respond to "convincing political arguments." Rational arguments are more important for the community at large. There are two kinds of Convincing Political Argument. One is the creation of a new vested interest that is as powerful in terms of political donations, influence in the media and contributions to the economy as the old vested interests…The second type arises from the more diffuse kind of power or empowerment that can be exercised by a mass movement of (progressive organisations and) citizens…If the vast array of groups and individuals, making up such a movement can agree on common principles, goals and strategies, the movement can be almost irresistible to any government that wishes to stay in office and to any opposition party wishing to achieve office. Such a mass movement would include

[27] Hamilton, C. (1999) '*Running From the Storm'*, Pluto Press.

sympathetic businesses, professional organisations, trade unions, churches and environmental non-government organisations (NGOs)".[28]

So the third part of this chapter overviews progress on strategies to both create new vested interests for positive change and build a global mass movement for action on climate change. But as outlined in Chapter 1 and above, the Stern Review target of 60 per cent by 2050 is now regarded by many eminent climate scientists as insufficient. So now economists are modelling scenarios, with even tougher targets, for greenhouse gas reductions than contemplated by Stern. The Australian Garnaut Review has argued that OECD countries like Australia should commit to a 90 per cent reduction target by 2050 as part of a Post Kyoto International Agreement. Thus currently economic modelling is researching broadly the costs of mitigating climate change under broadly three possible scenarios.

i) ***A Firm Scenario****, which aligns with the current target committed to by many national governments of 60 per cent by 2050 with a 20 per cent by 2020 target. This is what many EU nations have already committed to undertaking, and what the Stern Review[29] and most economic modelling to date has investigated.*

ii) ***A Strong Scenario,*** *which aims to achieve, under a global agreement, a peaking of global greenhouse emissions by 2015, a reduction of 25-40 per cent by 2020 and a target of 80-100 per cent by 2050. This aligns the long term target, recommended by the Garnaut Review Interim Report[30] for Australia to adopt, if the rest of the world commits to a binding global agreement. This also includes the short term target discussed at the UN Bali Summit. This is what the IPCC 4th Assessment[31], the Australian Climate Institute[32], the McKinsey Group[33] and Schneider and Azar[34] have economically modelled.*

iii) ***A Global Emergency Scenario*** *– which examines the economic, social and technical feasibility of trying to reduce emissions as fast as by 2020 and by 2050 without preconceptions. Modelling of this scenario is yet to be published but this is what increasingly climate scientists are arguing nations and companies to do. Already four nations have committed to becoming net climate neutral rapidly. Thus in this chapter we*

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[28] Diesendorf, M (2007) *Greenhouse Solutions with Sustainable Energy*, UNSW Press, Sydney.

[29] Stern, N et al. (2006) *The Stern Review: The Economics of Climate Change*, Cambridge University Press, Cambridge.p104 Available at www.hmtreasury.gov.uk/independent_reviews/stern_review_economics_climate_change/Sternreview.index.cfm Accessed 14 April 2007

[30] See Garnaut Review Interim Report at http://www.garnautreview.org.au/CA25734E0016A131/pages/reports-and-papers

[31] Minchin, L. (2007) *'A Climate of Change'*, The Age , Australia . Available at http://www.theage.com.au/news/national/a-climate-of-change/2007/05/04/1177788398904.html?page=fullpage#contentSwap 1 Accessed 5 May 2007.

[32] Hatfield-Dodds, S., Jackson, E.K., Adams, P.D. and Gerardi, W. (2007), *Leader, follower or free rider? The economic impacts of different Australian emission targets*, The Climate Institute, Sydney, Australia. Available At http://www.climateinstitute.org.au/images/stories/CI058_ER_FullReport_NEW.PDF

[33] McKinsey & Company (2007) *Curbing Global Energy Demand Growth: The Energy Productivity Opportunity* McKinsey at www.mckinsey.com/mgi/publications/Curbing_Global_Energy/index.asp Accessed 22 January 2008

[34] Schneider,S. Azar, C (2002) *Are the Costs of Stabilising the Atmosphere Prohibitive*? Ecological Economics 42:73-80

bring together relevant literature to help inform future economic modelling of this third and ambitious scenario.

The three scenario's are chosen to represent the wide range of opinion currently about what level of speed and scale of decoupling of economic growth and greenhouse gas emissions is needed to prevent overshoot, reduce the risks of dangerous climate change and achieve environmental sustainability. It is useful therefore to look at recent economic modelling under three scenario's including the 60 per cent by 2050 and two tougher scenarios to see whether adequate decoupling to achieve environmental sustainability can be achieved without harming the economy significantly and thus test the central hypothesis of this thesis.

7.2 Under Different Scenarios, Can Decoupling of Economic Growth from Greenhouse Gas Emissions Always be Achieved Without Significant Cost to the Economy?

7.2.1 The Firm Scenario. Global cuts of 10-20 per cent by 2020 and a Firm Long Term Target of 60 per cent by 2050.

The Stern Review is the most thorough economic modelling study of this firm scenario on a global scale. Many nations have committed to at least 60 per cent reduction target for greenhouse gas emissions by 2050. Hence there is a wealth of technical and economic modelling to show how OECD nations can achieve this target (See Appendix 7.1 and 7.2). Using energy efficiency, renewable energy, demand management, sustainable transport approaches and Clean Development Mechanism opportunities, a wide range of economic studies show that at least 60 per cent can be achieved by 2050 with strong economic and jobs growth. (See Appendix 7.1 and 7.2)

The Australian Business Roundtable on Climate Change's (ABRCC) economic modelling is a good example of what the consensus is saying about the economic impacts of a 60 per cent by 2050 target.[35] The ABRCC has had a significant impact on the economic debates on climate change in Australia. Hence it is worth featuring as an example.

The ABRCC commissioned studies were significant in that they demonstrated for the first time the economic and business case for early action on climate change in the same report. The Roundtable showed that increasingly business in Australia is calling for early action on climate change as lack of certainty about future climate policy in Australia heightens the risks associated with investment. All sectors of the economy will be affected by climate change, and by emissions trading schemes and/or a carbon tax. For instance, The Energy Supply Association of Australia (ESAA) estimates that $30 billion of investment is required in the electricity sector over the next decade. Lead times for base load

[35] Formed in 2005, the Business Roundtable is made up of CEOs from BP, Insurance Australia Group, Origin Energy, Swiss Re, Visy Industries and Westpac with The Australian Conservation Foundation

generation are four to six years and these assets have long lives. In the absence of carbon risk, these investments would be driven by well known factors. But climate change is now a key factor in the decision-making process for base load generation. In the absence of a clear long-term framework on climate change, investor appetite for new large plants is likely to remain low due to potential risk. The ESAA has clearly stated that 'One of the biggest sovereign risk issues facing the energy sector is [the uncertainty surrounding] future Government policy and measures on emissions'.[36] One of the major barriers to business and government committing to a carbon price signal (and to the sustainable cuts needed), has been the perception that the costs of a carbon price (and committing to targets of 60% GHG reductions by 2050) would be prohibitive to business and the economy. The Australian Business Roundtable on Climate Change's reports,[37] published in April 2006, found there is no justification for such fears and concerns. They found that early action on climate change is far better for business than delaying it. They found that early action on climate change, to achieve a 60 percent reduction in greenhouse gas emissions by 2050, can still achieve strong economic growth. Specifically the economic modelling they commissioned found that[38]

- GDP still continues to grow by 2.1 percent pa and by 2050 will increase from AU$0.8 trillion in 2005 to AU$2 trillion in 2050. This occurs while Australia reduces emissions by 60 percent. Australian Bureau of Agriculture and Resource Economics' (ABARE) modeling shows GDP continuing to grow by around 2.1-2.2 percent pa with a 15-40 percent reduction in emissions.
- Real income per person, in 2050, will double from what it was in 2005. Put another way, in 1984 Australian GDP per person was AU$22,000 and it is now AU$44,000. Even if we reduce emissions by nearly two thirds this would double again to AU$88,000 by 2050. Employment would grow by 38.7 percent over the period of 2050 leading to the creation of 3.5 million jobs by 2050.
- Electricity costs would be lower as business invests earlier in low and zero emission technologies, when compared to taking delayed action. Future electricity price rises would be three times higher in the delayed action scenario in comparison with the early action scenario.

Conversely, if action on climate change is delayed in Australia then the costs of adoption will be far greater to business and governments at all levels, leading to a major disruptive shock to the Australian economy. The Australian Business Roundtable found that GDP growth would be limited to an average of 1.9 percent pa to 2050, or AU$1.84 trillion. Employment growth would only be 36.2 percent; 250,000 fewer jobs created than under early action.

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[36] Australian Business Roundtable on Climate Change (2006) The business case for early action, ABRCC. Available at www.businessroundtable.com.au. Accessed 14 April 2007

[37] Ibid.

[38] Ibid

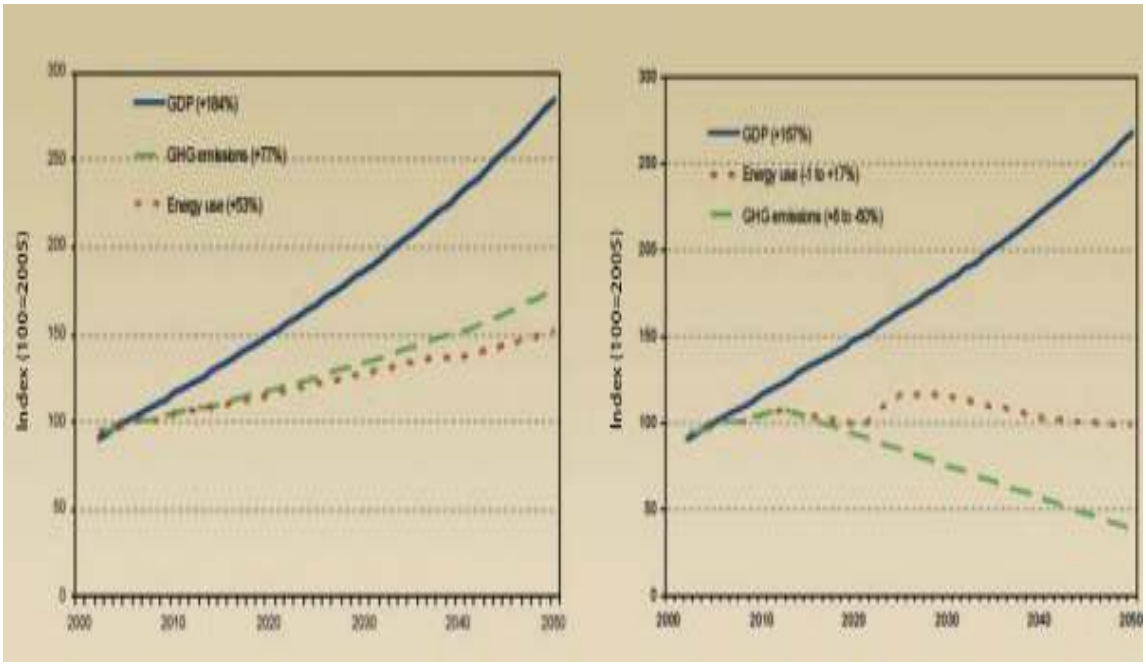

Figure 7.2: Decoupling economic growth and energy use from greenhouse gas emissions – projections for Australia without (Left) and with (Right) policy action, 2002–2050. (Source: Hatfield-Dodds, 2006[39])

Introducing an emissions constraint (a strong carbon price signal) gives economic value to emissions reductions and motivates action. Direct emitters, such as electricity generators, change their fuel mix (away from coal towards natural gas and renewables), and introduce new technologies such as carbon capture and storage as these become cost effective in light of a rising 'carbon price'. Energy users including consumers and other businesses

- choose more energy efficient appliances and technologies, which can reduce energy use while maintaining or improving the underlying energy service provided (such as a hot shower or commuter travel).
- change consumption patterns over time towards products and services with lower embodied emissions and energy. The increased attention to emissions and energy efficiency also has an important role in supporting environmental awareness and helping to identify win-win opportunities to reduce costs and improve the efficiency of resource use.
- Invest in carbon offset programs. Revegetation projects also benefit from the introduction of the carbon signal, which provides a new revenue source for biodiversity plantings and other 'carbon sinks' that offset emissions.

The UK Stern Review and the ABRCC economic models now show that a combination of emissions trading and/or a carbon tax plus other smart regulations and policies can effectively decouple

[39] Hatfield, Dodds, S (2007) *The Economic Impacts of Deep Cuts to Australia's Greenhouse Emissions*. CSIRO ECOS Published 31 January 2007 Available at http://www.publish.csiro.au/?act=view_file&file_id=EC134p12.pdf

greenhouse gas emissions and energy use from economic growth. In countries and states where smart regulations or emissions trading/carbon taxes have been brought in like California, USA and Sweden respectively there is already decoupling of economic growth and greenhouse gas emissions occurring as was shown in Chapter 5.

The UK Stern Review's conclusions on the effect of climate change on economic growth align well with the findings of the Australian Business Roundtable on Climate Change (ABRCC). The key message from the UK Stern Review, as with the Australian Business Roundtable, is that climate change poses a significant risk to the world economy and it will be cheaper to proactively address the problem than to deal with the consequences of inaction.[40] The ABRCC found that delayed action on climate change would put significant sectors of the Australian economy at risk, wreaking havoc with major tourist destinations, and hitting agriculture and forestry sectors hard with increasing risks of regular bush fires, and decrease in water flows. This has been corroborated by the IPCC's recent national assessment of Australia.[41]

7.2.2 The Strong Scenario –25-40 per cent by 2020 below 1990 levels, and a strong long term target of a net 80-100 per cent cut in greenhouse gas emissions by 2050

As discussed in Chapter 1 and in this chapter, many scientists now are warning that the 60 per cent by 2050 target will not be sufficient to avoid dangerous climate change. The IPCC 4th Assessment has published economic modelling to support their argument that the post Kyoto International Agreement should adopt future targets of at least 25-40 per cent by 2020 and 80 per cent cut by 2050. The IPCC's economic modelling shows that such targets could be achieved with negligible negative effect on the global economy. As Liz Minchin reported

> "The world has less than eight years to arrest global warming or risk what many scientists warn could be catastrophic changes to the planet. Its conclusion that global emission cuts of between 50 to 85 per cent would be needed to stop the temperature rising beyond two degrees. It found that slashing greenhouse emissions by up to 85 percent could cost only 0.12 per cent of global gross domestic product a year to 2050."[42]

The 2008 McKinsey Global Institute[43] climate change mitigation study argues that it is economically cost effective to aim for and achieve such strong short term targets due to the cost effectiveness of

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[40] Stern, N. (2006) *The Stern Review: The Economics of Climate Change*, *Executive Summary* Cambridge University Press, Cambridge, p10. Available at. http://www.hm-treasury.gov.uk/media/8AC/F7/Executive_Summary.pdf. Accessed 13. February 2008

[41] IPCC (2007) *Fourth Assessment Report. WG2: Climate Change 2007: Impacts, Adaptation & Vulnerability,* IPCC. Available at http://www.ipcc.ch/SPM6avr07.pdf. Accessed 13. February 2008.

[42] Minchin, L. (2007) *'A Climate of Change'*, The Age , Australia. Available at http://www.theage.com.au/news/national/a-climate-of-change/2007/05/04/1177788398904.html?page=fullpage#contentSwap1. Accessed 5 May 2007

[43] McKinsey Global Institute (2008) *The Case for Investing in Energy Productivity*. McKinsey Global Institute. Available At http://www.mckinsey.com/mgi/reports/pdfs/Investing_Energy_Productivity/Investing_Energy_Productivity.pdf

investments in energy efficiency and from stopping global deforestation through compensation and new governance approaches. In addition to this global economic modelling, there has been modelling done for national economies in the last two years amongst the OECD. In Australia, for instance, CSIRO *et al*[44], Diesendorf,[45]the Clean Energy Group[46] and the McKinsey Group[47] have published significant work which shows that if Australia implements climate mitigation strategies and policy wisely Australia could meet strong targets without significantly harming economic growth. This body of work shows that Australia can technically and economically achieve a peaking in Australia's greenhouse gas emissions by 2012, a 20-30 per cent reduction by 2020 and a net 70-100 per cent reduction by 2050.[48]

Consider the 2007 CSIRO, The Climate Institute, Monash University and McLennan Magasanik Associates economic modelling and report.[49] This is a significant report, written and researched by many of Australia's best climate change mitigation economic modellers, backs up the 90 per cent by 2050 recommendation of the Garnaut Review's Interim Report. These experts examined a range of scenarios including one where leadership Australia goes further than 90 per cent by 2050 and instead goes net carbon neutral by 2050 (They assume Australia is part of a global CDM or emissions trading scheme and thus can achieve a net carbon neutral target). The analysis also did not factor in the climate change impact costs of inaction which The Stern Review have been estimated to be between 5-20% of global economic activity in 2100. Yet their critical report shows that if Australia's emissions peak by 2012, reduced by 20% by 2020 and then eventually became net carbon neutral[50] by 2050 that:

- Australian economic activity is projected to increase from less than $1 trillion now to around $3 trillion by 2050. To 2050, the economy grows at 2.8% annually versus 2.9% annually with no action on climate change (i.e a 0.1% annual reduction in GDP growth).
- Employment increases from 9.7 to 16.7 million jobs by 2050.

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[44] Hatfield-Dodds, S., Jackson, E.K., Adams, P.D. and Gerardi, W.(2007), *Leader, follower or free rider? The economic impacts of different Australian emission targets*, The Climate Institute, Sydney, Australia. Available At http://www.climateinstitute.org.au/images/stories/CI058_ER_FullReport_NEW.PDF Accessed 4th March 2008

[45] Diesendorf, M (2007) *Paths to a Low Carbon Future Reducing Australia's Greenhouse Gas Emissions by 30 per cent by 2020*. Sustainability Centre. Available At http://www.greenpeace.org/raw/content/australia/resources/reports/climate-change/paths-to-a-low-carbon-future.pdf Accessed 7 November 2007

[46] Saddler, H., Diesendorf, M. and Denniss, R. (2004) *A Clean Energy Future for Australia Energy Strategies*, WWF, Canberra. Available at http://wwf.org.au/ourwork/climatechange/cleanenergyfuture/. Accessed 14 April 2007

[47] Gorner, S. Lewis, A. Downey, L. Slezak, J. Michael, J. Wonhas, A. (2008) *An Australian Cost Curve For Greenhouse Gas Reduction.* McKinsey Consulting. Australia/New Zealand. This report argues that 30 per cent reductions by 2020 can be achieved largely through energy efficiency and carbon offsets. Available At http://www.mckinsey.com/locations/australia_newzealand/knowledge/pdf/1802_carbon.pdf Accessed 4th March 2008

[48] See References 45-49

[49] Hatfield-Dodds, S., Jackson, E.K., Adams, P.D. and Gerardi, W.(2007), *Leader, follower or free rider? The economic impacts of different Australian emission targets,* The Climate Institute, Sydney, Australia. Available At http://www.climateinstitute.org.au/images/stories/CI058_ER_FullReport_NEW.PDF Accessed 4th March 2008

[50] The modeling and report assume that Australia and Australian business will be able to invest in Clean Development Mechanism Projects as part of a Post Kyoto Framework. These investments make achieving a net carbon neutral target technically possible.

- Long term impacts on energy prices and affordability are manageable with average energy consumer bundle (electricity, petrol and gas) falling from 6% of average income today to 4% by 2050. (While electricity, petrol and gas prices increase this is more than offset by increases in real income.)
- The report concludes that, "making very substantial reductions in Australia's net greenhouse emissions is affordable, and compatible with continuing growth in incomes, employment and living standards."

The reports authors state that

> "The key finding of this report is that the leadership premium associated with Australia committing early to very substantial cuts in our net greenhouse emissions is modest and affordable, and would help manage the economic risks to Australia as well as contributing to the global momentum and concrete actions required to avoid dangerous global climate change."[51]

This CSIRO *et al* study[52] is significant as it shows that an 80-100 per cent target by 2050 using smart approaches to climate change mitigation and clean development mechanism projects is technically and economically viable for an OECD economy like Australia.

There has been significant opposition from certain sections of business in Australia to the Garnaut

As we argued in Chapter 4, business can also benefit from a strong and purposeful approach to climate change. Most assume that if nations adopt a strong approach to reducing greenhouse emissions that their businesses will lose competitiveness. In Chapter 4 we showed that competitiveness issues for trade exposed companies can easily be managed with a range of policy initiatives.[53] As we will show in 7.4 in this chapter there is now a wide range of studies which show there are significant energy efficiency opportunities for business.[54] Also climate change solutions, whether as products or services, will be the major next wave of innovation. Innovation in this area is occurring so fast that nations which do not commit strongly to the necessary investment in R&D for climate change solutions risk missing another wave of innovation just like most nations missed the ICT wave of innovation due to lack of public and private sector investment. Progress on innovation in LED lighting has quadrupled resource productivity in just

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[51] Hatfield-Dodds, S., Jackson, E.K., Adams, P.D. and Gerardi, W.(2007), *Leader, follower or free rider? The economic impacts of different Australian emission targets*, The Climate Institute, Sydney, Australia. Available At http://www.climateinstitute.org.au/images/stories/CI058_ER_FullReport_NEW.PDF Accessed 4th March 2008

[52] Ibid.

[53] Saddler, H, Muller, F & Cuevas, C (2006) *Competitiveness and Carbon Pricing: Border adjustments for greenhouse policies*, Discussion Paper 86, Australia Institute, Canberra, April

[54] Energy Efficiency and Greenhouse Working Group (2003) *Towards a National Framework for Energy Efficiency - Issues and Challenges Discussion Paper.* Available at http://www.nfee.gov.au/about_nfee.jsp?xcid=64 Accessed 14 April 2007.

four years since 2003. Commercialization of innovation in climate change mitigation called clean tech now receives as much venture capital in Europe as biotech and nanotech.

7.2.3 A Global Emergency Scenario – Achieving Greenhouse Gas Reductions as Fast as Possible to achieve at least 50 per cent Global Reductions by 2020 and Low Stabilization Targets by 2050.

The reason to include an even more ambitious global emergency scenario is that there are positive feedbacks within the world's biosphere to climate change which, once triggered, threaten to raise global temperatures significantly irrespective of what other greenhouse gas reductions are achieved. These were outlined in detail in Chapter 1 of this thesis and in Chapter 1 of the Stern review. The latest science published in 2007 shows that some of the positive feedbacks in the earth's biosphere are being activated faster than even the IPCC predicted for their 4th Assessment published in 2007. For instance, the artic sea ice could be completely melted as early as the summer of 2013, decades ahead of what the IPCC had predicted.[55] Even before this critical development in the rate of artic sea ice melt, Al Gore has called, what is occurring now with climate change, a planetary emergency in his address to several committees of the US Congress and Senate.[56]

It is important to discuss the implications of the latest science on the question of what rate of decoupling needs to be achieved of economic growth and greenhouse gas emissions? Stephen Schneider and Azar[57] showed that over a 100 year time scale very deep cuts to greenhouse gas emissions can be achieved with negligible effect on economic growth. But if deep cuts have to be achieved by 2020 or 2050 and the rate of decoupling needed globally now is greater than seven per cent per annum, (as argued by Garnaut in the Garnaut Review Interim report). Can this be done with still negligible effect on economic growth?

This thesis assumes that humanity needs to avoid dangerous climate change, as defined by the IPCC in their 4th Assessment, as a pre-requisite to being able to achieve environmental sustainability. Climate scientists of the calibre of NASA's James Hanson are arguing that, due to the latest scientific evidence from the 2007 summer ice melt, even 25-40 per cent reduction in global emissions by 2020 and 80 per cent by 2050 is insufficient to sufficiently reduce the risks of dangerous climate change.[58]

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[55] Sutton, P. Spratt, D (2008) *Climate 'code red': The case for a sustainability emergency*. Available at http://www.climatecodered.net/ Accessed 7 March 2008

[56] Barringer, F. Revkin, A (2007) *Gore Warns Congress of 'Planetary Emergency'* New York Times. March 22 2007 Available at http://www.nytimes.com/2007/03/22/washington/22gore.html

[57] Schneider,S. Azar, C (2002) *Are the Costs of Stabilising the Atmosphere Prohibitive*? Ecological Economics 42:73-80

[58] Sutton, P. Spratt, D (2008) *Climate 'code red': The case for a sustainability emergency*. Available at http://www.climatecodered.net/ Accessed 7 March 2008

Spratt and Sutton have brought together the latest science published since the IPCC 4th Assessment stopped taking new evidence to argue that there is need for nations to commit to decoupling economic growth from greenhouse gas as fast as possible. They argue that pursuing even this very rapid transition to a low carbon economy need not harm economic growth but rather could help it. They point to historical examples of nations undertaking rapid restructuring of the whole of the economy in WW2 through which it is possible to examine the effects of such a rapid restructuring on economic growth. WW2 provides a large body of empirical data of what happened during a extremely rapid transition of the economy. The historical evidence, for example of the emergency mobilization in the USA for the 1939-45 war, shows that a rapid restructuring of the economy in WW2 led to an economic boom. In the USA, between 1940–1945, unemployment in the USA fell from 14.6% to 1.9%, whilst GNP grew 55%. In the USA in 1942 economic growth was 12 per cent for that year. Wages grew 65% over the course of the War to far outstrip inflation, and company profits boomed, all at a time when personal consumption was dampened by the sale of war bonds, some basic goods and foods were rationed and at the height of the mobilisation 40% of the economy was directed towards the war effort. WW2 wartime economic history suggests that a rapid restructuring to achieve a low carbon economy need not crash the economy, rather it can boost economic growth since restructuring boosts investment and thus increases GDP.

But such historic evidence does not prove that the world could undertake such a war economy like rapid transition to a low carbon economy whilst maintaining strong economic growth. This historic evidence about GDP growth rates during WW2 merely suggests that it is worth further investigating and researching further whether or not an as rapid as possible scenario is achievable by 2020 to quickly decouple economic growth to achieve a low carbon economy.

Further evidence of the value of undertaking new research into a still more ambitious scenario, comes from other business reports. The Environment Business Australia *Targets for Our Future* report outlined vital research which, for the first time, argues that Australia could achieve 50 per cent cuts to greenhouse gas emissions by 2020.[59] The report stated that

> "With a rapid introduction of new policies and systems the following approaches could deliver over 50% GHG emissions cuts by 2020 through the following strategies. Energy efficiency 20%, recycling 10%, fuel switching 10%, hot rock geothermal 2%, solar thermal 10%, photovoltaics 2%, and wind 5%"

The Environment Business Australia's (EBA) report emphasizes the significant opportunities for Australian industry and business if the Australian government leads. Thus this report addresses significantly one of the major areas of research for the Garnaut Review namely

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[59] Environment Business Australia (2007) *Targets for our Future:20% greenhouse gas emissions cuts by 2020 and 60% by 2050.* Available At: http://environmentbusiness.com.au/images/stories/targets_for_our_future-_september_07.pdf Accessed 13. February 2008

> "The economic and strategic opportunities for Australia from playing a leading role in our region's shift to a more carbon-efficient economy, including the potential for Australia to become a regional hub for the technologies and industries associated with global movement to low carbon emissions."

McKinsey Consulting is a highly respected global business group. They have recently released detailed studies[60] which should how Australia could achieve 30 per cent cuts by 2020 and 60 per cent cuts by 2030 highly cost-effectively through investing mainly initially in energy efficiency, co-generation and carbon offsets from stopping forest burning and deforestation in Asia. Under a global or national emergency scenario it is not inconceivable that the level of investment required to achieve 60 per cent cuts by 2030 could be brought forward to achieve at least 50 per cent cuts by 2020.

The EBA and McKinsey have been accused of being overly optimistic. As I will show in section 7.4, detailed energy efficiency research for the Australian economy funded by CSIRO and NFEE[61] shows that they have not exceedingly over-estimated Australia's energy efficiency opportunities, rather they are in accord with both existing NFEE studies[62] and findings from government programs and energy efficiency consultants. But, at the very least, such research does uncover important lessons and cost effective ways to rapidly achieve rapid greenhouse gas reductions in specific sectors of the economy. For instance a new report[63] released in late 2007 by Telstra identifies seven ways that telecommunications can reduce Australia's national greenhouse gas emissions by five per cent by 2015. Just 12 months ago Telstra did not know this. Just 12 months ago such information was not available for decision makers to estimate what are realistic targets for Australia. There are similarly large information gaps in many countries now trying to estimate realistic targets for 2020 and 2050 to take to the next UN Climate Change meetings.

Another reason for considering the global emergency scenario is that climate change is emerging as one of the major national security threats of coming decades. To avoid future conflicts and wars governments and citizens may decide that it is politically acceptable to have greater government intervention to achieve a faster transition to a low carbon economy.

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[60] Gorner, S. Lewis, A. Downey, L. Slezak, J. Michael, J. Wonhas, A. (2008) *An Australian Cost Curve For Greenhouse Gas Reduction.* McKinsey Consulting. Australia/New Zealand. This report argues that up to 30 per cent reductions by 2020 as being possible. Available At http://www.mckinsey.com/locations/australia_newzealand/knowledge/pdf/1802_carbon.pdf Accessed 4th March 2008.

[61] Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C., and Hargroves, S. (2007) *Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation*, The Natural Edge Project (TNEP), Australia.' Available At www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx Accessed 13. February 2008

[62] National Framework for Energy Efficiency (NFEE) (2003) *Towards a National Framework for Energy Efficiency – Issues and Challenges Discussion Paper*, NFEE. Available at http://www.nfee.gov.au/about_nfee.jsp?xcid=64. Accessed 7 November 200

[63] Telstra (2007) *Towards a High Bandwidth:Low Carbon Future*. Telstra Available At: . http://www.climaterisk.com.au/wp-content/uploads/2007/CR_Telstra_ClimateReport.pdf

In defence and security circles, it is common to examine all possible scenarios when assessing risks. Now that some security experts are arguing that climate change is a significant security risk this century, in the next decade it could be well seen as appropriate to fund a proper investigation of a national emergency scenario of rapidly mitigating climate change as fast as possible. Head of Australian Federal Police, Mike Kelty fears climate change more than terrorism. The region of the Asia Pacific will be particularly negatively affected by climate change increasing the risks of conflict, refugees, and lawlessness. Climate change will reduce by at least half the available water from rivers which depend on snow melt from the Himalayan plateau. In China by 2040, climate change could mean 30 per cent less land for rice and grain at a time when it needs to be boosting its food production by 40 per cent to meet rising population demands. As Mick Kelty stated:

> "We could see a catastrophic decline in the availability of fresh water. Crops could fail, disease could be rampant, and flooding might be so frequent that people en masse would be on the move. Even if only some and not all of this occurs, climate change is going to be the security issue of the 21st century. It's not difficult to see the policing implications that might arise in the not too distant future."[64]

Already islands are being overwhelmed by sea level rises in the Pacific and Bangladesh only needs a half a meter to a meter rise in sea levels to force 50-100 million to migrate. Most of the mega cities in Asia are on low lying river deltas which are very vulnerable to the slightest sea level rises. Professors Dupont and Pearman have outlined the security risks of climate change in detail in their Lowy Institute paper[65] in 2006.

Another reason for investigating a very rapid decoupling global emergency scenario is that in many nations investment for rapid restructuring of the economy is needed anyway in

- Cities and the transport sector to address record high oil prices, peak oil, congestion, urban pollution and diseases of inactivity such as obesity.
- The agricultural and forestry sector to address drought, declining water availability, extreme weather events and temperature changes.
- Broadband infrastructure to improve national productivity and communications which will also enable video-conferencing and smart meters which will reduce greenhouse gas emissions.[66]
- Tourism globally which are dependant on coral reefs or ski fields
- Cities, infrastructure and businesses operating on land currently below 1 meter above sea level.

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[64] Lauder, S (2007) *Police Commissioner enters climate change debate.* ABC. Available at http://www.abc.net.au/am/content/2007/s2042303.htm

[65] Dupont, A. Pearman, G. (2006) *Heating up the planet: climate change and security*. Available At http://www.lowyinstitute.org/Publication.asp?pid=391

[66] Telstra (2007) *Towards a High Bandwidth:Low Carbon Future*. Telstra Available At:http://www.climaterisk.com.au/wp-content/uploads/2007/CR_Telstra_ClimateReport.pdf

Hence governments, business and citizens may decide that, since significant investment, restructuring and compensation is needed anyway, why not ensure that future restructuring also brings about a transition to a low carbon economy.

Whichever short and long term greenhouse gas reduction targets are chosen by nations, achieving those targets will be greatly helped by a bipartisan approach to climate change to help ensure a consistent investment environment for business and the community. Every nation has precedents where there has been a national crisis so big that both major political parties agreed to take a bipartisan approach to solve a problem.

Whichever greenhouse gas reduction targets are chosen to decouple economic growth from greenhouse gas emissions, it is important analyse the most cost effective ways to rapidly reduce emissions.

- If you subscribe to the firm or the strong scenario, then you will still agree that it is important to research and implement the most cost effective ways to achieve rapid decoupling because the greater the reductions achieved by 2020, the less annual reductions in greenhouse gas emissions are required from 2020 to 2050 to achieve 60 to 100 per cent by 2050 from 1990 levels.
- If you subscribe to the global emergency scenario like NASA climate scientist Hansen[67], or Spratt and Sutton[68], then all you are interested in is how to rapidly reduce emissions by 2020.

The next part of this chapter investigates a portfolio approach of ten key climate change mitigation strategies to enable the rapid decoupling of economic growth from greenhouse gas emissions. These ten key climate change mitigation strategies are considered to investigate how realistic it is for rapid decoupling to occur without harming economic growth and because an understanding of them influences the assumptions economists make in their economic models on the costs and benefits of climate change.

As the Stern Review clearly states, the choice of assumptions made by economists explains largely why studies on the economic costs of emission reduction predict a range of -1.0 per cent to 3.5 per cent of global GDP.[69] In other words the choice of assumptions is so significant that it changes the conclusion of the economic modelling from either finding that action on climate change helps, barely effects or slightly harms economic growth. By necessity economic modelling requires assumptions to

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[67] Hansen, J., M. Sato, *et al.* (2007), *Climate change and trace gases*, Phil. Trans. Royal Soc. 365: 1925-1954, doi:10.1098/rsta.2007.2052, Available At http://pubs.giss.nasa.gov/abstracts/2007/Hansen_etal_2.html Accessed 8.01.08

[68] Sutton, P. Spratt, D (2008) *Climate 'code red': The case for a sustainability emergency*. Available at http://www.climatecodered.net/ Accessed 7 March 2008

[69] Stern, N. (2006) *The Stern Review: The Economics of Climate Change*, Cambridge University Press, Cambridge. Available at www.hmtreasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm. Accessed 13. February 2008 p260

be made. A number of studies[70] have shown that some economists historically have underestimated the costs of inaction and overestimated the economic costs of rapid action to achieve a transition a low emission economy quickly.[71] How these assumptions effect economic modelling is important for policy makers to understand because these assumptions which are sensitive variables in the economic modelling highlight areas where government, through good policy, can make a difference.

Professor John Weyant[72] has identified key areas where assumptions made by economists significantly affect the results of their modelling in this area. Professor John Weyant identified five key areas where assumptions made by economists significantly affect the results of their modelling in this area. One of the key assumptions in the models that Weyant refers to is the way in which the models deal with technological change, which is the critical issue that we are dealing with here. Weyant concludes that it probably does not make much difference in the short term but, over the longer term, say ten years or more, induced technological change could be a very substantial contributor to reducing the costs of reducing emissions. That makes sense, because we are actually talking about not only the development but also the adoption of new technologies which you would expect to take a decade or more to really have a big impact on the economy.

Economic modellers tend to be conservative in the assumptions they make but recent events suggest that it may be possible for very rapid diffusion of more energy efficient products and appliances to occur.

When the previous Federal Government announced that it would phase out inefficient lighting by 2012,[73] the European Union, California, and even the Philippines rapidly followed suit. This is having a significant flow-on effect by driving a change among global manufacturers in China, Europe and North America to focus on more energy efficient lighting products. The same concept could be applied tactically to other appropriate household, office, catering/hospitality and industry appliances or equipment. The lighting precedent suggests that if Australia committed to a phasing out the least energy efficient of these it more than likely would encourage the EU and California, for example, to rapidly follow, providing direct incentives to global manufacturers to fast-track more energy efficient products globally. As the next part of this chapter will show there is also much that can be done to ensure the rapid uptake of existing highly energy efficient products in developing countries The rate at which energy efficient products from the OECD are taken up in developing countries will also significantly affect the costs predicted by economic models.

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[70] Weyant, J. (2000) *An Introduction to the Economics of Climate Change Policy*, prepared for the Pew Center on Global Climate Change, Stanford University, July

[71] Lovins, A. Lovins, H (1997) *Climate: Making Money Making Sense*. RMI

[72] Weyant, J. (2000) *An Introduction to the Economics of Climate Change Policy*, prepared for the Pew Center on Global Climate Change, Stanford University, July

[73] Department of Environment and Water Resources (2007). *World first! Australia slashes greenhouse gases from inefficient lighting.* Available at www.environment.gov.au/minister/env/2007/pubs/mr20feb07.pdf

The next ten climate mitigation strategies are also discussed because they demonstrate where the main opportunities are for the world and business to achieve the most cost effective and largest greenhouse gas reductions quickly by 2020. Thus an understanding of these ten areas of opportunity to reduce greenhouse gas emissions quickly will provide a sophisticated portfolio approach from which nations can apply to help bring about a global peaking and then rapid reduction in greenhouse gas emissions under either a firm, strong or global emergency scenario's outlined above.

i) Assumptions about energy efficiency potential in the global economy.

ii) Assumptions of potential reductions through demand management.

iii) Assumptions about the potential of energy efficiency and demand management to delay the need for new electricity power plants and grid infrastructure.

iv) Assumptions about the viability and costs of renewable energy to meet peak and base load requirements.

v) Assumptions about the costs of a transition to a low carbon transport sector.

vi) Assumptions about the costs of reducing non-co2 emissions.

vii) Assumptions about what greenhouse abatement is possible through clean development mechanism projects in a post kyoto framework.

viii) Assumptions about how money from emissions credits is recycled and rebound effects.

ix) Assumptions about rebound effects

x) Assumptions about the costs of inaction on climate change

7.3 Costs and Benefits of Taking Rapid Action to Decouple Economic Growth from Greenhouse Gas Emissions

7.3.1 Assumptions about Energy Efficiency Potential in the Global Economy

The first and most important assumption made by economists when analysing costs and benefits of action on climate change is their assumptions concerning to what extent energy efficiency opportunities still exist in the economy. As discussed in Chapter 4.12, conventional micro-economic theory assumes that the firm maximizes profits by incorporating an optimal mix of labour, capital and other inputs in accordance with a standard production function, using fixed technologies freely available to all industry participants. It assumes that under perfect competition any inefficiency will be eliminated. Under these assumptions, efforts to reduce greenhouse emissions would be expected to add costs to an idealized firm that has already maximized its profits through implementing any cost effective cost cutting strategies. All economists know that real markets are far from theoretical perfection. However, many climate/economy models assume that close to perfect markets do exist and hence that most profitable energy savings must have already been achieved. On this basis, the

modellers suppose, buying significantly bigger savings will be worthwhile only at higher energy prices. They then use complex computer models to calculate how high an emissions trading scheme and a carbon energy tax is needed (based on historic elasticity), and hence what the 'cost' of protecting the climate must be.

On the other hand, bottom-up technological engineering modelling approaches recognize barriers that may have inhibited firms from taking advantage of potentially profitable energy-saving opportunities. There are significant market failures which daily prevent energy efficiency opportunities from being taken up. These bottom-up estimates typically predict that policy initiatives can induce reductions in energy consumption. As a result, bottom-up technological engineering modelling approaches typically suggest less economic disruption from government or private sector initiated energy efficiency programmes to reduce global greenhouse gas reductions. Not only do other economic models derive the opposite answer from actually acknowledging that savings are possible through energy efficiency measures, but an enormous body of overlooked empiricism, including government-sponsored studies and worldwide business practice, shows that many of the technological breakthroughs that we need to at least get started already exist.

McKinsey & Company has found that, through investing in energy efficiency, global emissions could be reduced by 20 per cent by 2020 without harming economic growth.[74] This aligns well with UK Carbon Trust and EU studies which have investigated the energy efficiency potential for the EU economy. Economic modelling by the National Framework for Energy Efficiency has shown that if Australia as a whole implemented 50 per cent of available energy-efficiency opportunities having a four-year or less payback, this would increase real GDP by AU$1.8 billion and create 9000 new jobs in addition to the environmental benefits.[75]

As Chapter 4 outlined using energy more efficiently offers an economic bonanza for business because saving fossil fuel is a lot cheaper than buying it. Energy-efficiency savings are the quickest, easiest and most cost-effective way for business and Australia to reduce greenhouse emissions. Energy efficiency gains for industry can come in a variety of ways, including lower capital costs and operating costs, increased yields, and reductions in other resource use such as water. Any energy efficient industrial technology improvement will incorporate one or more of these improvements. Some energy efficiency improvements may primarily be aimed at one goal, but also generally include beneficial impacts on other aspects of a production process. For instance, as Lawrence Berkeley National Laboratory's explain

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[74] See McKinsey&Company (2007) *Curbing Global Energy Demand Growth: The Energy Productivity Opportunity*. McKinsey&Company at www.mckinsey.com/mgi/publications/Curbing_Global_Energy/index.asp Accessed 22 January 2008

[75] National Framework for Energy Efficiency (NFEE) (2003) *Towards a National Framework for Energy Efficiency – Issues and Challenges Discussion Paper*, NFEE. Available at http://www.nfee.gov.au/about_nfee.jsp?xcid=64 Accessed 13. February 2008

> "certain designs or technologies that are identified as being 'energy-efficient' because they reduce the use of energy will bring a number of additional enhancements to the production process."[76]

These improvements include lower maintenance costs, increased production yield, safer working conditions, and many other 'productivity benefits' or 'non-energy benefits', because in addition to reducing energy, they all increase the productivity of the firm. Several authors have studied the relationship between productivity and energy efficiency and found a direct relationship using different methodologies and datasets.[77]

Our 640 page synthesis textbook resource[78], funded by CSIRO and NFEE, shows that business, governments, organisations and households can reduce greenhouse gas emissions significantly through energy efficiency and then using the savings from energy efficiency to invest in renewable energy, carbon offsets, sustainable transport and changes in consumption patterns within a few years once they commit to act. This resource[79] features existing real case studies and/or designs of

- Households rapidly retrofitted reducing emissions by over 60 per cent.
- (virtually) net climate neutral buildings.[80]
- Low carbon ways to process minerals and recycle metals.[81]
- Net climate neutral manufactured products.[82]
- Net climate positive paper and pulp mills.[83]
- Food processors that can reduce emissions by 30-80 per cent through energy efficiency, onsite co-generation and/or renewable energy.[84]

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[76] Worrell, E et al (2001) Productivity benefits of industrial energy efficiency measures. LBNL at http://ies.lbl.gov/iespubs/productivitybenefits.pdf,

[77] Boyd, G.A. and Pang, J.X. (2000) *'Estimating the linkage between energy efficiency and productivity'. Energy Policy,* vol 28, no. 5, pp 289–296; Kelly, H.C., Blair, P.D. and Gibbons, J.H. (1989) '*Energy use and productivity: current trends and policy implications',* Ann. Rev. Energy, vol 14, pp 321–352; US Department of Energy (1997)*The interrelationship between environmental goals, productivity improvement, and increased energy efficiency in integrated paper and steel plants*, US Department of Energy, Office of Policy and International Affairs and Office of Energy Efficiency and Renewable Energy, DOE/PO-0055, Washington, DC cited in Worrell, E et al (2001) Productivity benefits of industrial energy efficiency measures. LBNL at http://ies.lbl.gov/iespubs/productivitybenefits.pdf,

[78] Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C., and Hargroves, S. (2007) *Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation*, The Natural Edge Project (TNEP), Australia.' Available At www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx. Accessed 13. February 2008

[79] Ibid.

[80] Ibid. See Lectures 2.1-2.3, 5.3, 9.1 and 9.2 Available At www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx . Accessed 13. February 2008

[81] Ibid. See Lecture 5.1 Opportunities for Energy Efficiency in the Aluminium, Steel and Cement Sectors at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture5_1

[82] Ibid. See Lecture 5.2: Opportunities for Energy Efficiency in Manufacturing Industries at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture5_2

[83] Ibid. See Lecture 5.2: Opportunities for Energy Efficiency in Manufacturing Industries at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture5_2

- Supermarkets and bakeries that use 40 per cent less energy than market average through energy efficiency initiatives.[85]
- Fast food retail outlets that use 40-70 per cent less energy than market average through energy efficiency and better design.[86]
- Lighting[87], HVAC[88] and motor systems[89], that use at least 10-30 per cent less energy than the industry average.
- Office IT systems and servers that together use over 60 per cent less energy and[90]
- public street lighting[91] that is at least 50 per cent more energy efficient than current mercury street lighting.

Also, in the transport sector

- Overseas cities that are rapidly shifting to sustainable transport patterns.[92]
- Cars[93] and trucks[94] that are at least 50 per cent more fuel efficient than those using the internal combustion engine.
- The telecommunications sector can help Australia reduce Australia's greenhouse gas emissions by 5 per cent by 2015.[95]

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[84] Ibid. See Lecture 6.2: Opportunities for Energy Efficiency in the Food Processing and Retail Sector at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture6_2

[85] Ibid. See Lecture 6.2: Opportunities for Energy Efficiency in the Food Processing and Retail Sector at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture6_2

[86] Ibid. See Lecture 6.3: Opportunities for Energy Efficiency in the Fast Food Industry athttp://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture6_3

[87] Ibid. See Lecture 2.2: Opportunities for Energy Efficiency in Commercial Buildings http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture2_2

[88] Ibid. See Lecture 2.3: Opportunities for Improving the Efficiency of HVAC Systems http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture2_3

[89] Ibid. See Lecture 3.1: Opportunities for Improving the Efficiency of Motor Systems http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture3_3

[90] Ibid. See Lecture 5.3: Opportunities for Energy Efficiency in the IT Industry and Services Sector http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture5_3

[91] See ICLEI Public Street Lighting at http://www.iclei.org/index.php?id=6473

[92] Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C., and Hargroves, S. (2007) *Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation*, The Natural Edge Project (TNEP), Australia.' Available At www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx . Accessed 13. February 2008 See Lecture 8.1: Designing a Sustainable Transport Future at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture8_1

[93] Ibid. See Lecture 8.2: Integrated Approaches to Energy Efficiency and Alternative Transport Fuels – Passenger Vehicles at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture8_2

[94] Ibid. See Lecture 8.3: Integrated Approaches to Energy Efficiency and Alternative Transport Fuels – Trucking at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture8_3

[95] Telstra (2007) *Towards a High Bandwidth:Low Carbon Future*. Telstra Available At: . http://www.climaterisk.com.au/wp-content/uploads/2007/CR_Telstra_ClimateReport.pdf

Other evidence showing how technically such large energy efficiency reductions can be achieved over the next couple of decades is outlined in the 2009 publication Whole System Design[96]. This research and that of Alan Pears[97] shows that there is still significant potential for energy efficiency savings in household appliances, office, catering and industrial equipment.

Since urgent action is needed on climate change and energy efficiency offers the most cost effective way to rapidly achieve greenhouse gas reductions, it is worth considering what are other barriers to the uptake of energy efficiency opportunities.

7.3.1.1 What are the Barriers to the Uptake of Energy Efficiency Opportunities?

The Australian Government's Discussion paper on a National Framework for Energy Efficiency[98] highlights a range of barriers to the uptake of energy efficiency, outlining for instance the need for greater capacity building among business and technical professionals concerning energy efficiency opportunities. In the UK government, the UK Carbon Trust[99] is developing education and training on energy efficiency opportunities by technology[100] and by sector.[101] These modules do the same for Australia.

There are other market, informational and institutional barriers to the uptake of energy efficiency opportunities which also need to be addressed if Australia is to realise the billions of dollars of potential economic savings possible from energy efficiency. As shown in Chapter 4, market failures, such as split incentives can lead to energy efficiency opportunities being ignored. There have been a number of barriers like these to the uptake of energy efficiency opportunities, but around the world there are examples where governments, business and professional organisations have addressed and overcome such perverse barriers. Amory and Hunter Lovins summarised examples of where such barriers have been overcome to the implementation of energy efficiency opportunities in their seminal 1997 paper *Climate: Making Money, Making Sense*.[102]

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[96] Stasinopoulos, P., Smith, M., Hargroves, K. and Desha, C. (2009) Whole System Design Suite. An Integrated Approach to Sustainable Engineering, Earthscan. London. Available at http://www.naturaledgeproject.net/Whole_Systems_Design_Suite.aspx

[97] Pears, A (2004) *Misconceptions About Energy Efficiency – Its Real Potential: Some Perspectives and Experiences.* Background paper for International Energy Agency Energy Efficiency Workshop, Paris April 2004 N.d http://www.naturaledgeproject.net/NAON_ch17.aspx (Accessed May 2007

[98] Ibid, p 7.

[99] See UK Carbon Trust website at www.carbontrust.co.uk. Accessed 3 September 2007.The UK Carbon Trust is the pre-eminent energy and climate change education and training organization in the UK.

[100] UK Carbon Trust (2007) *Savings by Technology* , UK Carbon Trust. Available at http://www.carbontrust.co.uk/energy/startsaving/technology.htm. Accessed 3 March 2007.

[101] UK Carbon Trust (2007) *Energy Efficiency Savings Opportunities: by Sector*, UK Carbon Trust. Available at http://www.carbontrust.co.uk/energy/startsaving/sector.htm. Accessed 3 March 2007.

[102] Lovins, A. and Lovins, L (1997) *Climate: Making Money, Making Sense*, Rocky Mountain Institute, Colorado, pp 16-25. Available at http://www.rmi.org/images/PDFs/Climate/C97-13_ClimateMSMM.pdf Accessed 3 September 2007.

7.3.1.2 What are the Major Barriers to Energy Efficiency Opportunities in Developing Countries

The 2007 study, by McKinsey & Company, which shows that investing in energy efficiency could reduce global emissions by 20 per cent by 2020, included the major fast growing countries like China and developing countries.[103] Countries such as China[104], India[105] and Brazil, are now making increasingly significant commitments to energy efficiency in recognition of the win-win opportunities. But there are still significant barriers to investment in energy efficiency in many developing countries, such as low awareness of the benefits of energy efficiency, finance reservations, and the general lack of energy efficiency training amongst the global pool of engineers.

Yet there are already examples of projects that have begun to successfully address these barriers from which both OECD and non-OECD countries can learn a great deal. The starting point is raising community awareness about the benefits of energy efficiency. For example, since all citizens, organizations and government agencies need lighting, investing in energy efficient lighting is an ideal place to start to raise community awareness about the benefits of energy efficiency generally. Poland's Efficient Lighting Project (PELP),[106] funded by the Global Environment Facility (GEF), [107] is widely regarded as the model success story here.

In Poland, in 1995, though economical in the long run, a compact fluorescent lightglobe (CFL) required an off-putting upfront investment of as much as US$15.00. An incandescent bulb cost just 40 cents. But under the Poland Efficient Lighting Project, OECD nations, through The Global Environment Facility (GEF), committed 5 million dollars to provide an incentive to Polish CFL manufacturers, wholesalers and retailers to help bring down the upfront cost of CFLs.

As a result, more than 1.6 million new compact fluorescent lights[108] (CFLs) were installed through Poland from 1995 to 1998. This increased the uptake of globes from one in every ten homes to one in every three homes by 1998. At 2004, about one in two homes in Poland used a CFL and the project had saved an estimated 2320 gigawatt-hours of electricity – a reduction of 2.8 million tons of CO emissions.

The GEF's incentives were carefully administered. CFL manufacturers had to engage in competitive bidding to be part of the program and this led to pledges of additional manufacturers' discounts. A manufacturer's discount of, say, 50 cents (US$), would mean that a GEF CFL price reduction

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[103] See McKinsey&Company (2007) *Curbing Global Energy Demand Growth: The Energy Productivity Opportunity* McKinsey at www.mckinsey.com/mgi/publications/Curbing_Global_Energy/index.asp Accessed 22 January 2008

[104] See China Energy Bulletin www.energybulletin.net/3566.html

[105] See India Bureau of Energy Efficiency at www.bee-india.nic.in/ Accessed 22 January 2008

[106] See Poland's Efficient Lighting Project (PELP) at www.un.org/esa/sustdev/mgroups/success/2000/PCBCP-4.htm

[107] The Global Environment Facility (GEF), established in 1991, helps developing countries fund projects and programs that protect the global environment. www.gefweb.org/default.aspx

[108] CFLs last eight to ten times longer than normal incandescent electric bulbs and consume only a quarter of the electricity.

incentive of $1.50 led to a total price reduction of $2.00. Importantly, negotiations with wholesalers and retailers ensured that they too adjusted their margins accordingly. If the original manufacturer's price was then $6.00, the price to the wholesaler was subsequently only $4.00. The wholesalers' and retailers' reduced markups, as well as value-added tax, were then also calculated on a lower original price. So instead of a manufacturer's price of $6.00 resulting in a retail price of $12.00, a manufacturer's adjusted price of $4.00 led to a sales price of only $8.00. Of course all this required the initial commitment of US$5 million, twelve years ago, but it illustrates the power of the mechanism. There has also been a fall in CFL costs over that time to consider.

Such was the success of this program that the GEF then funded the $15 million dollar Efficient Lighting Initiative (ELI) from 2000-2003 to foster the efficient lighting market in Argentina, the Czech Republic, Hungary, Latvia, Peru, Philippines, and South Africa.[109]

There is a significant opportunity for OECD countries to fund similar energy efficiency incentive schemes through the GEF to encourage more countries to adopt energy efficient products and services, thereby changing community attitudes to energy efficiency.

Another opportunity arises from the potential of light emitting diodes. Advances in ultra efficient lighting, such as LED, creates another significant opportunity. As Professor Mills, from the US Lawrence Berkeley Labs wrote in the journal Science:

> "An emerging opportunity for reducing the global costs and greenhouse gas emissions associated with this highly inefficient form of lighting energy use is to replace kerosene fuel-based lamps with white solid-state ("WLED") LED lighting which can be affordably solar-powered. Doing so would allow those without access to electricity in the developing world to affordably leapfrog over the prevailing incandescent and fluorescent lighting technologies in use today throughout the electrified world."[110]

Australian company Barefoot Power[111] is working on such LED projects in developing countries. There are a range of global initiatives addressing these opportunities to help developing countries with CFLs and LEDs to leapfrog the west.

Meanwhile, the Three Country Energy Efficiency Project (3CEE[112]) – involving China, India, Brazil – has run from 2002 to 2006 to address barriers to lack of local investment in energy efficiency. 'Many energy efficiency projects quickly pay for themselves, with typical returns on investment of 20-40%,' says Chandra Govindarajalu, a senior World Bank environmental specialist working with the 3CEE program. Despite the demonstrated benefits, though, companies often cite other, more immediate investment and borrowing priorities. Meanwhile, commercial banks in these countries are generally

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[109] See International Finance Corporation Energy Efficient Lighting Initiative Story at www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/p_ELI/$FILE/ELI_FINAL.PDF

[110] Mills, E. (2005) *The specter of fuel-based lighting*. Science 308(May 27):1263-1264. Available at www.sciencemag.org/cgi/content/summary/308/5726/1263

[111] See Barefoot Power at http://www.barefootpower.com/aboutus.html

[112] See 3 Country Energy Efficiency Project At http://3countryee.org/

unfamiliar with financing projects designed to achieve cost savings, rather than develop new product lines or other tangible assets.'[113]

To address these issues, the 3CEE Project has worked with the banking and finance sector to promote energy efficiency projects. It is a joint initiative of the World Bank, the UN Environment Programme's Denmark-based Risoe Centre (URC), and partners in Brazil, China and India.[114] World Bank consultant Jeremy Levin, who worked on the project, said:

> "Chinese commercial banks were wary of making any investments that weren't practically guaranteed. Because of this, the World Bank effectively co-signed the loans from the banks to Chinese ESCOs for up to 90 percent of the loan amounts. In the end, the World Bank guaranteed U.S. $36.4 million in loans over 52 projects, which resulted in energy savings that cut 102 700 tons (93 100 metric tons) of Chinese carbon dioxide emissions per year."

The 3CEE project has been instrumental in making local banks recognize the soundness of investments in energy efficiency projects. It is a matter of getting the first couple of loans going. With wider uptake, confidence in the mechanism grows and barriers to financial facilitation for such projects reduce.

As more countries commit to stronger energy efficiency targets, and different avenues for cooperatively reducing emissions are found there will be a great need for more expertise to assist with developing the mechanism.

7.3.2 Assumptions of Potential Reductions through Demand Management

Reducing greenhouse gas emissions through rapid reductions in peak[115]and base load[116]demand can be achieved through targeting energy efficiency and demand management strategies. International case studies suggest that it is possible for peak load electricity demand to be reduced in a matter of months with tariff reform and smart metering backed up by government programs to assist the energy efficient retrofitting of homes.[117] In states around the world where they have implemented smart metering and tariff reform to provide lower rates during off-peak periods, significant reductions in peak electricity loads have occurred. In Florida, electricity suppliers Georgia Power and Gulf Power have

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[113] See UNEP (2006) *Fighting Climate Change through Energy Efficiency* at ww.unep.org/Documents.Multilingual/Default.asp?DocumentID=477&ArticleID=5276&l=en

[114] The UN Foundation and the World Bank Energy Sector Management Assistance Program provided financial support, with complementary activities supported by the Asia Alternative Energy Program and the UK Department for International Development.

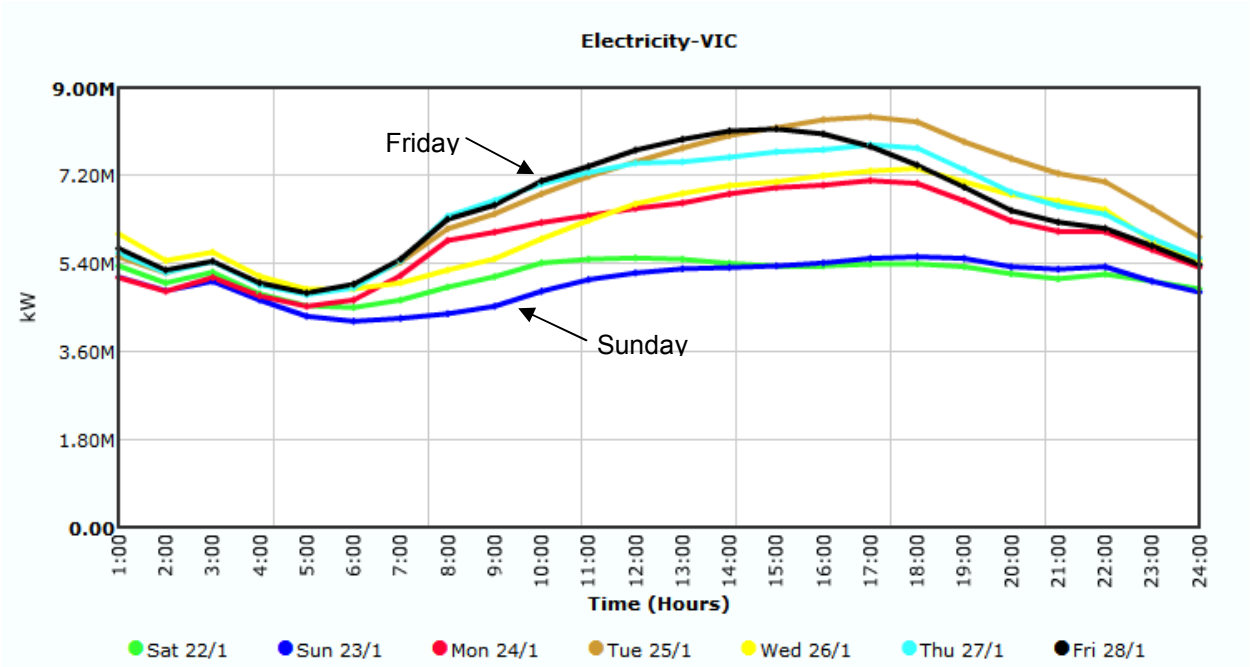
[115] Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C., and Hargroves, S. (2007) *Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation*, TNEP. See Lecture 4.2: Demand Management Approaches to Reduce Rising 'Peak Load' Electricity Demand at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture4_2

[116] Ibid See Lecture 4.3: Demand Management Approaches to Reduce Rising 'Base Load' Electricity Demand at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture4_3

[117] Smith, M. and Hargroves, K (2007) 'Smart Approaches to Electricity Use', CSIRO ECOS, Issue 135, pp12-13

implemented smart meters and real time pricing with remarkable results. For Georgia Power, large customers reduced electricity demand by 20-30 percent during peak periods. For Gulf Power, a 41 percent reduction in load during peak times was achieved.[118] One of the reasons why smart meters and tariff reform can lead to such dramatic reductions is that there are significant energy efficiency opportunities in the residential sector. In most OECD countries the residential sector contributes significantly to summer and winter peak electricity demand.[119] Most energy efficiency savings in the residential sector can be identified and implemented very quickly. The recent ABC TV series *Carbon Cops*[120] illustrates this point. Six family and student households all reduced their greenhouse gas emissions by over 60 per cent in a matter of weeks, while also halving their energy bills.

Similarly base load electricity demand in Australia could be reduced in half. Baseload electricity describes the electricity used by the economy 24 hours a day, seven days a week. Given the size of the Australian service industry, commercial building and residential market, it is clear that there should be a significant reduction in electricity used at night and over the weekend. However this is not the case. Research by Genesis Auto shows that in NSW and Victoria there is very little variation between electricity base-load between weekdays (when one would expect the highest base-load) and between 10pm-5am or weekends (when one would expect the lowest base-load electricity demand). (See Figure 7.7)



[118] Ibid.

[119] Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C., and Hargroves, S. (2007) *Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation,* TNEP.See Lecture 4.1:What Factors are Causing Rising Peak and Base Load Electricity Demand in Australia? www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture4_1

[120] See ABC TV Carbon Cops at http://www.abc.net.au/tv/carboncops/ Accessed 13. February 2008

Figure 7.3: Victoria's Summer Electricity Demand (GW) Saturday 22 January 2005 to Friday 28 January 2005. Includes Australia Day public holiday showing much higher load than the Saturday and Sunday. (Source: Genesis Auto, 2007)

This suggests that there is significant potential to reduce base-load electricity demand in Australia between 10pm and 5am and on weekends through using timers to switch off what does not need to be left on. In Italy they have instituted regulations that require commercial buildings to turn their lights off after 12am to save electricity and reduce greenhouse gas emissions. Research by energy efficiency experts Alan Pears and Geoff Andrews suggests that most organisations leave at least 5-10% of equipment, lighting or appliances on that does not need to be.[121]

Australia is blessed with very cheap energy compared to most OECD countries, due to abundant coal reserves. This has led to many businesses, commercial buildings and households simply leaving on machinery, lighting, appliances, air-conditioning and heating throughout the night and over weekends rather than ensuring that such equipment turns off when it is not needed. Government energy efficiency programs have found that commercial buildings can save as much as 70 percent over the weekend simply by ensuring that more efficient lighting and air-conditioning is used and turned off when not needed. Australia wastes over 10 percent of all electricity generated simply through leaving domestic appliances on standby which could otherwise be turned off. This results in Australia's base load electricity being a higher percentage of total electricity usage than other OECD nations. Australia's base load electricity usage is 70 percent while the UK's is 40 percent. Significant reductions in base load and peak load electricity demand can be achieved through investing in even half of the 70 percent energy efficiency potential in the Australian economy. Such investment could be assisted if government and industry worked together to address barriers to the uptake of more energy efficient practices. Geoff Andrews, Director of Genesis Auto, says that, after twenty years as an energy-efficiency consultant

> "Our experiences have led us to conclude that roughly 50 per cent of the base load electricity usage we find should not be there. For instance street lighting at night can easily be made 50 per cent more energy efficient. Hospitals run 24 hrs, 7 days a week, so it might be reasonable to expect a flat load profile. But then you ask about the areas in a hospital which aren't 24 hrs 7 days a week – consulting rooms, admin, laundry, kitchen, x-ray, central sterilising, maintenance, pathology – and more often than not there is still a flat load profile. Also I am still amazed at the portion of base load contributed by storage-based electric water heaters both for commercial and residential buildings. A huge portion of the

[121] Pears, A (2004) *Misconceptions About Energy Efficiency – Its Real Potential: Some Perspectives and Experiences*. Background paper for International Energy Agency Energy Efficiency Workshop, Paris April 2004 N.d http://www.naturaledgeproject.net/NAON_ch17.aspx (Accessed May 2007)

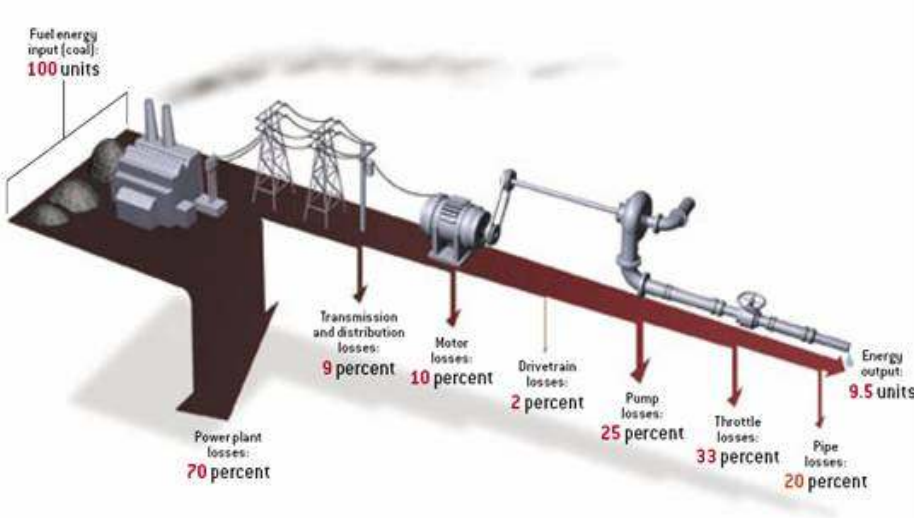
buildings we see have electric water heaters inconspicuously losing heat supplied with electricity from coal."[122]

7.3.3 Assumptions about the Potential of Energy Efficiency and Demand Management to Delay the Need for New Electricity Power Plants and Grid Infrastructure

Improvements in end-use energy efficiency and demand management on a large enough scale could save tens of billions in infrastructure costs by delaying permanently the need to build new power stations and extend the electricity grid over coming decades in Australia. Improvements in end use energy efficiency on a large enough scale can also reduce infrastructure costs from reducing peak and base load electricity demand, thus helping to keep electricity costs down. As the authors of *Natural Capitalism* wrote[123]

> "From the power plant to an industrial pipe, inefficiencies along the way whittle the energy input of the fuel - set at 100 arbitrary units in this example - by more than 90%, leaving only 9.5 units of energy delivered to the end use. Small increases in end-use efficiency can reverse these compounding losses. For instance, saving one unit of output energy will cut the needed fuel input by 10 units, slashing cost and pollution at the power plant."

Hence by focusing on end use efficiency a cascade of savings can be created all the way back to the power plant. (See Figure 7.4) This is why a focus on achieving end use energy efficiency gains in engineered systems such as motors, HVAC systems, commercial buildings, appliances and office equipment can help Australia reduce greenhouse gases significantly.



[122] Geoff Andrews, Director GenesisAuto (2007) Private Communication.

[123] Hawken, P. *et al* (1999) *Natural Capitalism: The Next Industrial Revolution*, Earthscan Publishing, London, Chapter 6: Tunnelling Through the Cost Barrier. Available At www.natcap.org Accessed 13. February 2008

Figure 7.4. From the power plant to an industrial pipe, inefficiencies along the way whittle the energy input of the fuel - set at 100 arbitrary units in this example - by more than 90 percent, leaving only 9.5 units of energy delivered to the end use.

(Source: RMI, 2005)[124]

Such energy efficiency opportunities exist in all countries globally and thus provide a way to achieve rapid cuts to greenhouse gas emissions globally.

There are many potential beneficiaries of a greater uptake of energy efficiency and peak and base load management in Australia: retailers can gain financially through lower exposure to peak price risks for wholesale energy; business and consumers through lower energy bills and better energy services; and the community generally through better utilisation of resources and fewer environmental costs. Demand management is a proven least-cost approach to meeting customers' needs for electricity services. Reducing the demand for electricity not only reduces the cost to business and the consumer but also reduces the requirement to maintain and build new electricity generation infrastructure, especially the additional infrastructure required to meet peak period demands that is then redundant for the rest of the time. As the *NSW Independent Pricing and Regulatory Tribunal Inquiry* found in 2002[125]

> "This is the situation NSW is increasingly facing. If no action is taken on the demand side of the market, additional capital expenditure of $1.5 billion to $3 billion may be required over the next 10 years. This is in addition to foreshadowed network capital expenditure of $5 billion, a significant proportion of which may be required to meet growth in demand."

The Tribunal summed up the seriousness of this issue when it stated

> "The Tribunal is very concerned about the potential for substantial increases in capital expenditure and worsening asset utilisation, with adverse consequences for costs faced by end-users. Already, 10 per cent of network capacity is required for less than 1 per cent of the year. This will worsen if demand continues to get peakier and networks have to invest in new network capacity to meet this demand. Potentially massive increases in network expenditure to meet demand growth highlight the importance of getting demand management right."[126]

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[124] Lovins, A.B. (2005) '*More Profit with Less Carbon'*, Scientific American, Sept. 2005. See the extended bibliography at www.rmi.org/sitepages/pid173.php#C05-05. Accessed 13. February 2008.

[125] Independent Pricing and Regulatory Tribunal of NSW (2002) *Inquiry into the Role of Demand Management and Other Options in the Provision of Energy Services, IPART*. Available at http://www.ipart.nsw.gov.au/electricity/documents/InquiryintoRoleofDemandManagementandOtherOptions-FinalReport.pdf. Accessed 4 September 2007. pp i.

[126] Ibid.

The National Framework for Energy Efficiency (NFEE) has commissioned a wide range of modelling that has revealed major economic benefits to Australia from significantly reducing electricity demand and thereby delaying the need for new infrastructure and networks.[127] This can help the economy, as shown in the analysis undertaken by McLennan Magasanik Associates[128] (under business-as-usual assumptions)

> "[About] 1,000 MW of new capacity per annum is required across the electricity supply sector from about 2009/10 onwards. Although not all of this capacity will be base load, about 500 MW to 700 MW is likely to be required for high load duty. Energy efficiency initiatives, which target base load sources, will delay the need to invest in this new capacity... Benefits were estimated to range from $2.4 billion to $6.6 billion. Energy efficiency initiatives that both reduce running costs to business and delaying the need to invest in new capacity can provide between $2.54 and $6 Billion in benefits to Australia. "[129]

There are also commercial benefits to electricity utilities in delaying the need to build new plants because it reduces the risks of potential economic losses if

- Forecast demand fails to meet projections, or
- If the construction of plants runs over schedule, or
- If there are sudden changes to energy and climate policy that makes different supply options more economical.

There is considerable evidence from overseas that where electricity utilities have encouraged energy efficiency in the community it has helped to boost the local economy and thus improve the bottom line of the electricity utility as well.

Take the now classic case of the town of Osage, Iowa, where the Municipal Utilities Department successfully implemented an energy efficiency program as far back as 1975. The principal beneficiary of the program has been the town's economy. Osage Municipal Utilities has been able to reduce electricity rates by 19 percent during the last eight years and natural gas rates by five percent during the last five years.[130]In addition the program reduced unemployment to half that of the national

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[127]National Framework for Energy Efficiency (2007) *Commissioned Modelling Studies for Australia*, NFEE. Available at http://www.nfee.gov.au/about_nfee.jsp?xcid=65. Accessed 2 June 2007.

[128] McLennan Magasanik Associates (2004) *National energy efficiency target Modelling for the National Energy Efficiency Framework*, MMA. Available at http://www.nfee.gov.au/default.jsp?xcid=41. Accessed 2 June 2007.

[129] Ibid.

[130] See Smart Communities Network - *Green Buildings Success Stories* at http://www.smartcommunities.ncat.org/success/osage_muni.shtml. Accessed 2 June 2007.

average as the lower electricity rates has attracted more factories and companies to town, while reducing the emissions and costs of the utility itself.[131]

There is significant experience globally in re-aligning incentives to reward electricity utilities for encouraging greater energy efficiency for their customers. This policy reform is a great example of how smart regulation can improve business profitability and the environment thus helping economic growth.

Governments could improve the existing regulatory frameworks to reward electricity utilities for helping their customers to use electricity more efficiently. Currently there is little incentive for electricity utilities to move in this direction

> "Electric utility experts have recognised for a long time that under regulatory structures (eg: traditional rate-of-return regulation, rate caps etc) utilities do not have an economic incentive to provide programs to help their customers be more energy-efficient. In fact, they typically have a dis-incentive because reduced energy sales reduce utility revenues and earnings. The financial incentives are very much tilted in favour of increased electricity sales and expanding supply side systems. "[132]

Hence in the past, electric utilities have often opposed and lobbied against sustainable development type initiatives such as a utility run customer energy efficiency program and carbon emissions trading schemes. A new report[133] has investigated how to re-align incentives and regulations to ensure that electric utilities and customers can create a win-win situation from sustainable development.

Their report has found that there are at least 25 states in the USA with serious utility rate-payer-funded energy efficiency programs in operation, all with very positive results. All of these states have addressed the traditional disincentives by introducing some type of cost recovery mechanism for these energy efficiency programs for the electric utility (e.g. a public benefits charge plus the ability to recover additional energy efficiency costs in rates). Other examples include:

- Decoupling of utility revenues and profits through legislation to reward utilities for selling less energy. Generally in these new regulatory frameworks customers received 85 percent of those savings as lower bills, while the utility's shareholders received the rest as extra profits, not to mention the direct savings in infrastructure from the reduced peak load generation requirement - the perfect win-win option for the energy supply sector. This was first introduced in California in 1992 .

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[131] National Renewable Energy Laboratory (1996) *The Jobs Connection: Energy Use and Local Economic Development*, produced for the US Department of Energy (DOE). The document was produced by the Technical Information Program, under the DOE Office of Energy Efficiency and Renewable Energy. Available at http://www.flasolar.com/pdf/energy_jobs.pdf. Accessed 12 May 2007.

[132] Kushler, M. (2006) *Aligning Utility Interests with Energy Efficiency Objectives: A Recent Review of Efforts at Decoupling and Performance Incentives*, P5. Available at http://aceee.org/pubs/u061.pdf?CFID=1902973&CFTOKEN=31285910). Accessed 14 April 2007.

[133] Ibid

> "Retaining 15% of the savings inspired Pacific Gas and Electric (PG&E) in 1992, the U.S.'s largest private utility, to put a halt to building or planning any new conventional power plants. PG&E found that they could address any subsequent increase demand for electricity through renewables. Using this method in California in 1992, PG&E134 invested over US$170 million to help customers save electricity more cheaply than the utility could make it. That investment created US$300–400 million worth of savings. Customers received 85% of those savings as lower bills, while the utility's shareholders received the rest—over US$40 million." [135]

- Providing shareholder 'performance incentives' for achieving energy efficiency program objectives. These can take several forms such as

> 'providing utilities with a specific reward for meeting certain targets, allowing utilities to earn a rate of return on energy efficiency investments equal to supply side and other capital investments or providing utilities with an increased rate of return either on the energy efficiency investment specifically or overall.'[136]

7.3.4 Assumptions about the Viability and Costs of Renewable Energy to meet Peak and Base Load Requirements

Carbon geosequestration and nuclear power will take at least ten years to make a significant difference to global greenhouse gas emissions. Renewable energy technologies can be implemented rapidly between now and 2020 to reduce emissions. Hence assumptions about the costs and benefits of renewable energy are critical in estimating the likely costs of short term greenhouse gas reduction targets for Australia.

Another major blind spot amongst many decision makers is that they cannot conceive of good demand management, energy efficiency and renewable energy addressing and meeting Australia's rising peak and baseload demand. This is because still many people incorrectly assume that renewable energy sources cannot supply base load electricity. Few appear to be aware of the range of sources that have refuted this belief since the early 1980s.[137] In fact, renewable distributed energy now accounts for one-quarter of California's installed capacity, one-third of Sweden's energy, half of Norway's and three-quarters of Iceland's. Since 2003, Denmark has also generated 20 per cent of its electricity from wind.

Many forms of renewable energy – such as hydro, biomass and geothermal – do not depend on day-to-day weather variations and hence can provide electricity all day, every day. Australia, with its wealth of gas and geothermal energy options is well positioned to compliment wind and solar power

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[134] This sensible program was mothballed when the 'deregulation' mania swept California, and set the state down the path to exporting billions of dollars to Enron and other Texas energy companies. But in the wake of the 2001 California Energy Crisis, it is coming back into fashion. Today, PG&E now runs an extensive Customer Energy Management Program that provides customers with access to energy efficiency experts in order to address demand-side energy efficiency and conservation.

[135] See RMI Saving the Utilities. Available at http://www.rmi.org/sitepages/pid322.php. Accessed 14 April 2007.

[136] Ibid

[137] Diesendorf, M (2007) *Greenhouse Solutions with Sustainable Energy*, UNSW Press, Sydney.

to, over time, reduce Australia's local dependency on coal. Wind, wave and tidal power can also provide base load electricity when used on a large scale separated by several hundred kilometres and subject to different wind, wave or tidal regimes. The total output of such systems generally varies smoothly; only rarely would such a system be in a situation of no wind, waves or tidal change at any site.

Graham Sinden from Oxford University has investigated the potential contribution of wind, solar, tidal, wave power and other renewable energy sources for electricity in the UK.[138] He concluded that most of the UK's electricity could be generated from renewables, with wind from dispersed sites providing the greatest contribution.[139]

Solar energy can also be stored at low cost as heat in water, rocks or thermo-chemical systems such as ammonia, enabling it to provide electricity 24 hours a day.[140] Solar thermal electric power plants convert solar energy to heat in order to drive a thermal power plant. Solar thermal[141] electricity can supply base load and is just as reliable as base load coal. Solar thermal base load electric systems have been around for 20 years.

Australian scientists have made world-class contributions to solar thermal research over the last 50 years.[142] As was recently reported on ABC TV's *7.30 Report*, two of America's biggest power utilities have unveiled plans for a multi-billion dollar expansion of solar power supply based on technology developed by a former Sydney University professor, Davíd Mills, now based in California. The utilities have confidently predicted that their solar power will soon be providing base-load electricity at prices competitive with coal. Indeed, according to a review by CSIRO scientists for the CRC for Coal in Sustainable Development, some experts now argue that the cost of concentrated solar thermal will become competitive to coal-fired generation when the former's installed capacity reaches 5000 MW worldwide by 2013.[143] The study's lead author, Dr Louis Wibberley from CSIRO, said 'What makes solar thermal particularly attractive is the fact that it integrates very well with existing technologies including coal, gas, biomass, photovoltaics and wind power.

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[138] Sinden, G. (2005) *Variability of Wave and Tidal Stream Energy Resources*, Oxford University Environmental Change Institute. A summary of the report and further information is available on the Carbon Trust's website at www.carbontrust.co.uk/NR/rdonlyres/EC293061-611D-4BC8-A75C-9F84138184D3/0/variability_uk_marine_energy_resources.pdf. Accessed 13. February 2008.

[139] Tickell, O. (2005) '*Wave, wind, sun and tide is a powerful mix'*, The Guardian, Thursday May 12 2005. Available at http://www.guardian.co.uk/life/opinion/story/0,,1481539,00.html. Accessed 13. February 2008

[140] Lovegrove, K. *et al* (2007) *Closed loop thermochemical energy storage system using ammonia,* ANU Solar Thermal Energy Research, Canberra. Available at http://engnet.anu.edu.au/DEresearch/solarthermal/high_temp/thermochem/index.php. Accessed 13. February 2008.

[141] Lovegrove, K. *et al* (2007) *Introduction to Concentrated Solar Thermal*, ANU Solar Thermal Energy Research, Canberra. Available at http://engnet.anu.edu.au/DEresearch/solarthermal/high_temp/concentrators/basics.php. Accessed 13. February 2008.

[142] Lovegrove, K. and Dennis, M. (2006) '*Solar thermal energy systems in Australia'*, International Journal of Environmental Studies, vol 63, no 6. Available at http://engnet.anu.edu.au/DEresearch/solarthermal/pages/pubs/IJES06.pdf. Accessed 13. February 2008.

[143] See Solar Thermal Warms Up – In Brief, CSIRO ECOS Issue 129 Available At http://www.publish.csiro.au/?act=view_file&file_id=EC129p4b.pdf Accessed 13. February 2008

The 20 per cent Minimum Renewable Energy Target by 2020 is a good start but for minimal extra cost Australia could achieve a 25 per cent target by 2020.[144] Combined with medium energy efficiency measures, the target would conservatively deliver: 16,600 new jobs, $33 billion in new investment, 15,000 MW new renewable capacity, 69 million tonnes reduction in electricity sector greenhouse emissions (almost as much as the total emissions from road transport), and enough renewable electricity to power every home in Australia. More than 17,000 Australians are already employed in renewable energy or energy efficiency. A 25 per cent target would increase the number of clean energy jobs to over 33,000.[145]

Allen Consulting's modeling[146] shows that if Australia implements energy efficiency opportunities these approximately offset over time the costs of rolling out renewable energy infrastructure. In 2002, The Economist magazine ranked Rocky Mountain Institute's publication, *Small is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size*[147] as its book of the year. This is because this book, for the first time, outlined 207 reasons why renewable distributed energy sources can often be a lower financial risk option to meet peak and base load electricity demand when combined with effective energy efficiency and demand management programs. Clearly covering all 207 reasons is beyond the scope of this thesis.[148] Here we consider four of the 207 hidden economic benefits that need to be taken into account by economic modellers to gain a more accurate cost benefit analysis of the costs of investment in renewable energy to business and the economy.

1. *Distributed renewable energy has significantly shorter lead times for construction than large scale centralised plants.* Shorter lead time means that the utility does not have to keep as much capacity under construction (which costs money and increases financial risk), to meet expected load growth in a timely fashion. Nearly twenty years ago, M.F.Cantley noted that, *'The greater time lags required in planning* [and building] *giant power plants mean that forecasts* [of demand for them] *have to be made further ahead, with correspondingly greater uncertainty; therefore the level of spare capacity to be installed to achieve a specified level of security of supply must also increase.*'[149] It takes only 4-7 months to install wind farms for instance while most nuclear power plants take at least five years to build. Coal plants can vary but similarly take some time to build.

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[144] CANA, Australian Conservation Foundation, Greenpeace (2007) *A Bright Future:25 per cent Renewable Energy by 2020*. Available At http://www.acfonline.org.au/uploads/res/res_a_bright_future.pdf Accessed 13. February 2008

[145] ACF, CANA et al (2007) *A Bright Future. 25 Per Cent Renewable Energy by 2020*. ACT. CANA. Available At http://www.cana.net.au/documents/25_RenewableEnergyforAustraliaby2020report_2007.pdf

[146] Allen Consulting (2003) *Sustainable Energy Jobs Report: A Report for the Sustainable Energy Development Authority,* The Allen Consulting Group, Sydney. http://www.allenconsult.com.au/publications/download.php?id=221&type=pdf&file=1

[147] Lovins, A.B. *et al* (2002) *Small is Profitable: the hidden economic benefits of making electrical resources the right size*, Rocky Mountain Institute, Colorado, p 173. Available at www.smallisprofitable.org/. Accessed 2 June 2007.

[148] Ibid.

[149] Cantley, M.F. (1979) *'Questions of Scale'*, Options '79, vol 3, International Institute for Applied Systems Analysis, pp 4-5.

2. *Slower to build, larger centralised power station's capacity overshoots demand in three ways.* The yellow/lightly shaded areas of Figure 7.5 show the extra capacity that large centralised units require to be installed before they can be used. Small distributed-generation modules do not overshoot as much; they can be added more closely in step with demand.

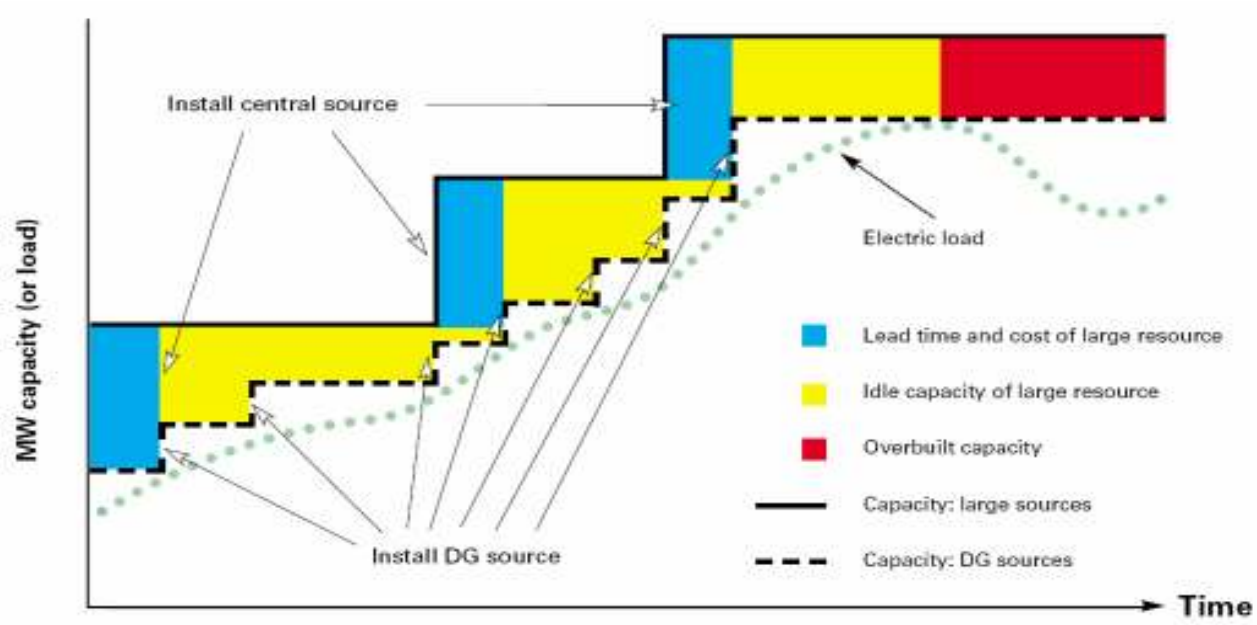


Figure 7.5. Comparison of capacity and cost implications of adding distributed generation (DG) versus centralised energy sources. (Source: Swisher, J. (2002))[150]

Note: The central source is available in large capacity increments and has a long lead-time. The DG source is available in flexible capacity increments and has a short lead-time. Option value benefits of DG compared to the central source include 1) increased lead-time and cost of central sources, 2) increased cost of idle capacity that exceeds existing load, and 3) increased cost of overbuilt capacity that remains idle.

Large centralised stations risk overshooting demand permanently if demand for electricity plateaus or declines, at any point, as shown by the red area. Given the energy efficiency opportunities to reduce peak and base load demand outlined in 7.3.1, it is possible for electricity demand to plateau and fall in the future. Historically there are examples where projections of future summer peak electricity demand have had to be ratcheted down significantly.

Figure 7.6 shows a comparison of annual 10-year forecasts of summer peak demand projections, and shows successive industry forecasts of US summer peak electric load continually reduced until they aligned with reality around 1984. The actual US peak load in the year 2000 (a summer

[150] Swisher, J. (2002) *Cleaner Energy, Greener Profits: Fuel Cells as Cost-Effective Distributed Energy Resources*, RMI, CO. Available at www.rmi.org/images/PDFs/Energy/U02-02_CleanerGreener.pdf. Accessed 2 June 2007.

about as hot as the 1949–2000 average) was 686 GW, slightly above the 'Actual' trend-line shown

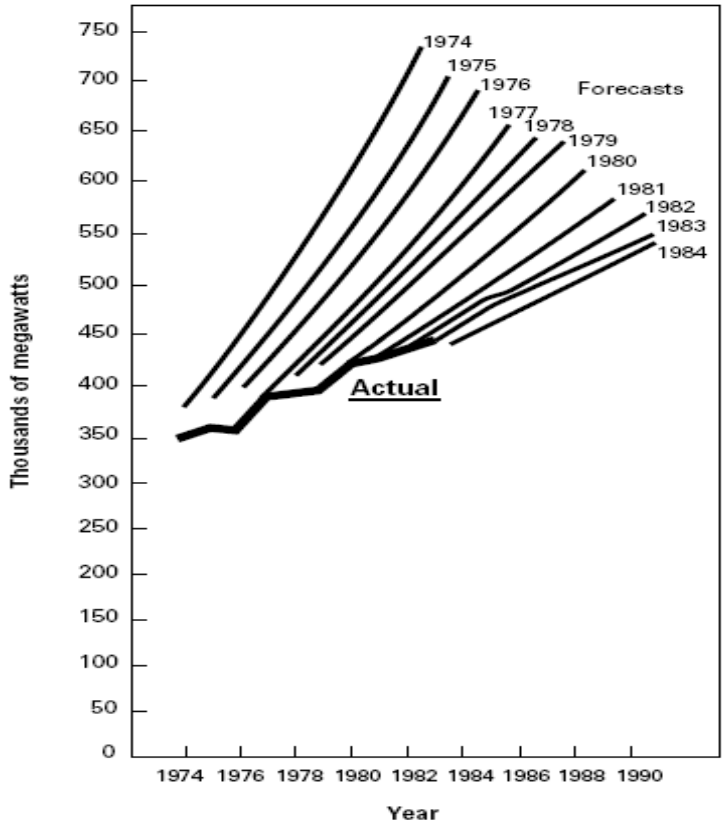


Figure 7.6 Industry forecasts of US summer-peak electric load

(Source: OTA (1985))[151]

3. *Shorter lead time means investments in distributed renewable energy can start earning revenue earlier - as soon as each module is built rather than waiting for the entire total capacity to be completed.* Modular plants can start yielding revenue while big, slower to build, centralised power stations are still under construction. This benefit has been quantified[152]in modelling using a model example of a 500-MW plant built in one segment over five years (to approximate a large centralised power station) vs. ten 50-MW modules with 6-month lead times (to approximate distributed energy generation approaches) (Figure 7.7). Assuming that each asset runs for 20 years, then under either plan, the same capacity operates identically with the same generation capacity for the middle 15 years, but the modular plant has higher revenue-earning capacity in the first five years. But because of discounting, the early operation is worth much more today. Using

[151] OTA (1985) *New Electric Power Technologies: Problems and Prospects for the 1990s*, OTA, p 45, fig 3.3.

[152] Hoff, T.E. and Herig, C. (1997) '*Managing Risk Using Renewable Energy Technologies'*, in Awerbuch, S. and Preston, A. (eds)*The Virtual Utility: Accounting, Technology and Competitive Aspects of the Emerging Industry*, Kluwer Academic, Boston. Available at www.cleanpower.com./research/riskmanagement/mrur.pdf. Accessed 2 June 2007.

a 10 percent/year discount rate and $200/MWy revenues, the modular solution will have return 31 percent higher revenue over the 20 year period.

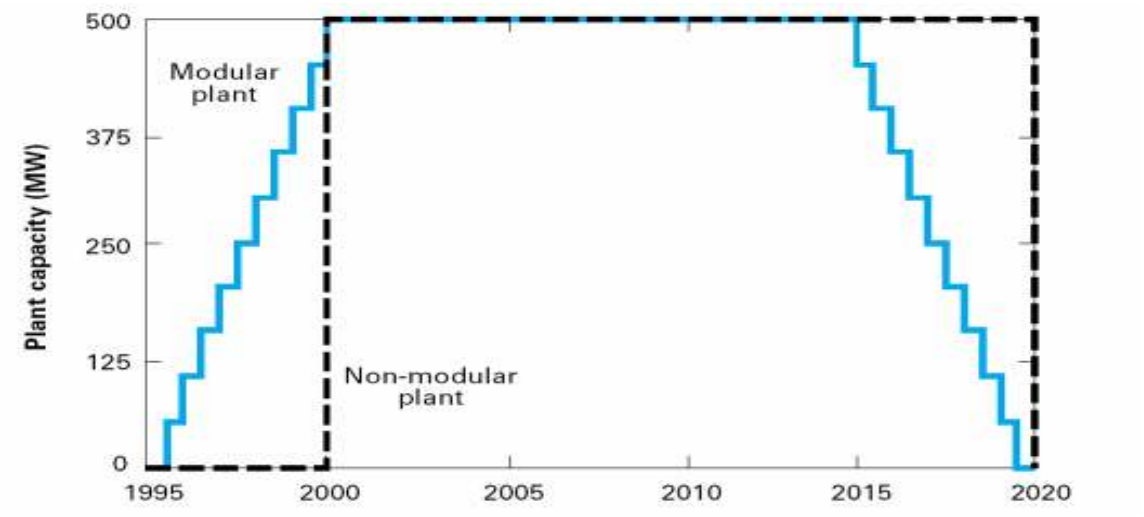
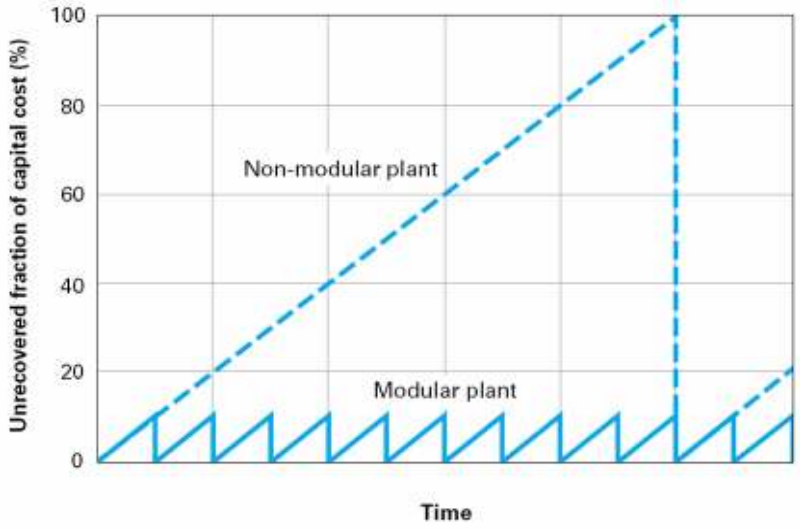


Figure 7.7. Modular resources' early operation increases their present value,

(Source: Hoff, T.E. and Herig, C. (1997))[153]

4. *Shorter lead time decreases the burden on utility cashflow* (as shown in Figure 7.8). Shorter lead time and smaller, more modular capacity additions can reduce the builder's financial risk and hence market cost of capital.[154] Distributed energy generation can be installed effectively in a modular fashion where additional wind farms are built if electricity demand is increasing. Built in this modular fashion, such an approach can need 10 plus times less working capital than large centralised electricity power stations or nuclear power plants, reducing default risk.



[153] Ibid, p. 22, fig. 7.

[154] Kahn, E. (1978) *Reliability Planning in Distributed Electric Energy Systems*, Lawrence Berkeley Laboratory, Berkeley, CA, p 333ff; Lovins, A.B. (1981) 'Electric Utility Investments: Excelsior or Confetti?', *Journal of Business Administration*, vol 12, no. 2, pp 91–114; Lovins, A.B. (1982) 'How To Keep Electric Utilities Solvent', *Energy Journal*.

Figure 7.8. Modular distributed energy plants reduce need for working capital.

(*Source:* Hoff, T.E. and Herig, C. (1997))[155]

The four benefits were first shown by a 1985 Los Alamos National Laboratory system dynamics study.[156] As Lovins *et al* described in *Small is Profitable*[157]

> "[The Los Alamos National Laboratory] analysts used a Northern California case study for Pacific Gas and Electric Company under the regulatory policies prevailing in the early 1980s. They examined how both the 'lead time' to plan, license, and build a generic power station and the financial or accounting cost of that lead time (due to real cost escalation and interest on tied-up capital) would affect its economic value over a 20-year planning horizon. However, to clarify choices, they inverted the calculation: Rather than modelling longer-lead-time plants as riskier or costlier (in present-valued revenue requirements), they simulated the utility's financial behaviour and asked how much 'overnight' (zero-lead-time) construction cost could be paid for the plant as a function of its actual lead time in order to achieve the same financial objectives.
>
> Adding also a similar analysis for a coal-fired utility[158] and another for Southern California Edison Company,[159] the Los Alamos team found that shorter lead times justified paying about one-third to two-thirds more per kW for a plant with a 10-instead of a 15-year lead time; that a 5-year lead time would justify paying about three times as much per kW; and that a 2.5-year lead time (analysed only for SCE) would justify paying nearly five times as much per kW. In each case, these far costlier but shorter - lead-time plants would achieve exactly the same financial performance as their 15-year-lead-time competitors under the same exogenous uncertainties, for the first five reasons listed above.

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[155] Hoff, T.E. and Herig, C. (1997) '*Managing Risk Using Renewable Energy Technologies'*, in Awerbuch, S. and Preston, A. (eds)*The Virtual Utility: Accounting, Technology and Competitive Aspects of the Emerging Industry*, Kluwer Academic, Boston, p. 26, fig. 9. Available at www.cleanpower.com./research/riskmanagement/mrur.pdf. Accessed 2 June 2007.

[156] Sutherland, R. J. et al (1985) The Future Market for Electric Generating Capacity: Technical Documentation, Los Alamos National Laboratory, Los Alamos, NM.

[157] Lovins, A.B. *et al* (2002) *Small is Profitable: the hidden economic benefits of making electrical resources the right size,* Rocky Mountain Institute, Colorado. Available at www.smallisprofitable.org/. Accessed 2 June 2007.

[158] Sutherland, R. J. *et al* (1985) *The Future Market for Electric Generating Capacity: Technical Documentation*, Los Alamos National Laboratory, Los Alamos, NM, pp 77-185.

[159] Ford, A. (1985) 'The Financial Advantages of Shorter Lead Time Generating Technologies and the R&D Cost Goals of the Southern California Edison Company', Proprietary study prepared for Southern California Edison, cited in Meade, W.R. and Teitelbaum, D.F. (1989) *A Guide to Renewable Energy and Least Cost Planning*, Interstate Solar Coordination Council (ISCC), p 11, ex. 8.

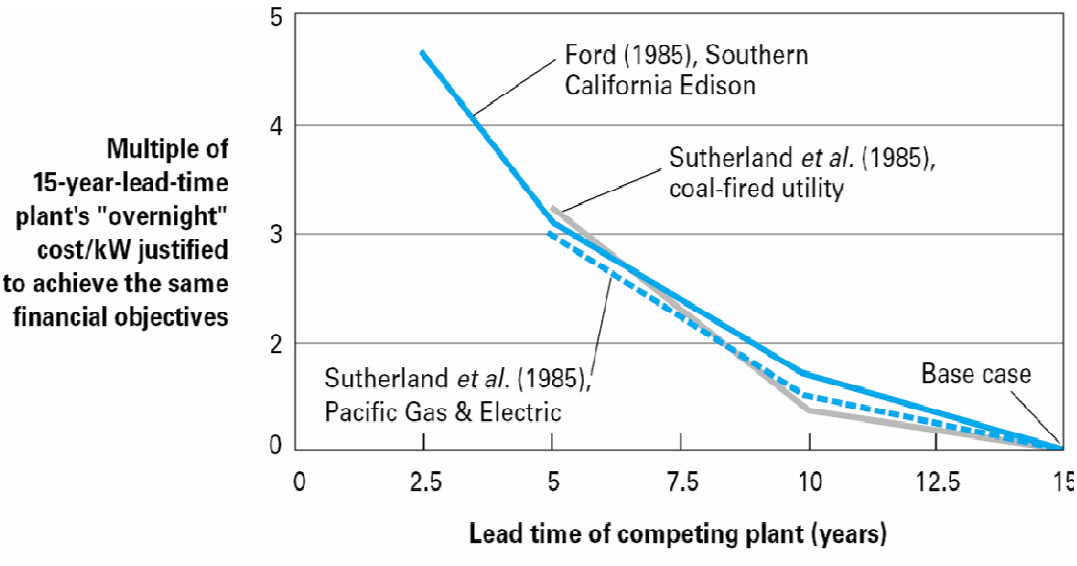

Figure 7.9. Power-plant financial feasibility vs. lead time. (*Source:* Meade, W.R. and Teitelbaum, D.F. (1989) and Sutherland, R.J. *et al.* (1985))[160]

For these reasons, decentralised sources of electricity – co-generation (the combined production of electricity and heat, typically from natural gas) and renewables (such as solar and wind power) - surpassed nuclear power in global generating capacity in 2002. The annual output of these low and no-carbon sources exceeded that of nuclear power in 2003. Solar, biofuels, geothermal, tidal and hydropower now represent a global market of AUD$74 billion, which is forecast to grow fourfold by 2015. For all these reasons renewable distributed energy is finally being acknowledged as a very effective solution to helping business and the whole economy meet rising peak and base load electricity demand. Allen Consulting[161] has shown the economic savings from energy-efficiency opportunities to be large enough to cover the cost of building new renewable energy infrastructure. In short, a smart combination of energy efficiency and renewable energy would have negligible negative effects on Australia's economic growth. Many businesses and organizations in Australia are reducing their energy usage through energy efficiency and then purchasing at least a percentage of their energy from accredited green power sources. This sort of approach by millions of households and thousands of businesses globally is leading to a rapid expansion of the renewable energy sector globally.

As can be seen in Figure 7.10, the annual output of these low and no-carbon sources exceeded that of nuclear power in 2003. The European Union has committed to improved energy efficiency and use of renewables, which it sees as key to their competitive advantage in the 21st century. The Energy Intelligent Europe Initiative, signed by Parliamentarians from all 15 member countries, calls for the

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[160] Meade, W.R. and Teitelbaum, D.F. (1989) *A Guide to Renewable Energy and Least Cost Planning*, Interstate Solar Coordination Council (ISCC), p. 11, ex. 8.; Sutherland, R. J. *et al* (1985) *The Future Market for Electric Generating Capacity: Technical Documentation*, Los Alamos National Laboratory, Los Alamos, NM, pp 145–146.

[161] Australian Business Roundtable on Climate Change (2006) *The business case for early action*, ABRCC. Available at www.businessroundtable.com.au. Accessed 14 April 2007

integration of energy efficiency and renewable energy as the basis for European competitiveness and high quality of life. The EU is seeking to source 22 percent of its electricity and 10 percent of its energy from such clean sources as wind within 10 years.[162] China, Japan, Canada and the North East and Western States of the USA are investing in renewable energy. Renewable energy is probably the greatest opportunity for developing countries to leapfrog the West. Developing nations can give the 2 billion people currently lacking access to electricity the energy they need, with for example, ultra energy-efficient lighting, solar cookers and renewable energy programs. Such an approach, as discussed in Chapter 6, can be relatively low cost and effective at getting the energy to where it is needed compared to building large, centralised power stations and a grid from scratch. This is partly because the cost of the electricity grid is typically about one third the overall cost of setting up a centralised electricity system. As discussed in Chapter 6, one more promising projects in this direction is the distribution of inexpensive solar cookers in Kenya by Solar Cookers International. Rapid advances in ultra efficient lighting, such as LED, over the last eight years creates another significant opportunity to combine energy efficiency improvements with renewable energy projects. There are other significant global energy efficient lighting global initiatives pursuing such strategies.[163]

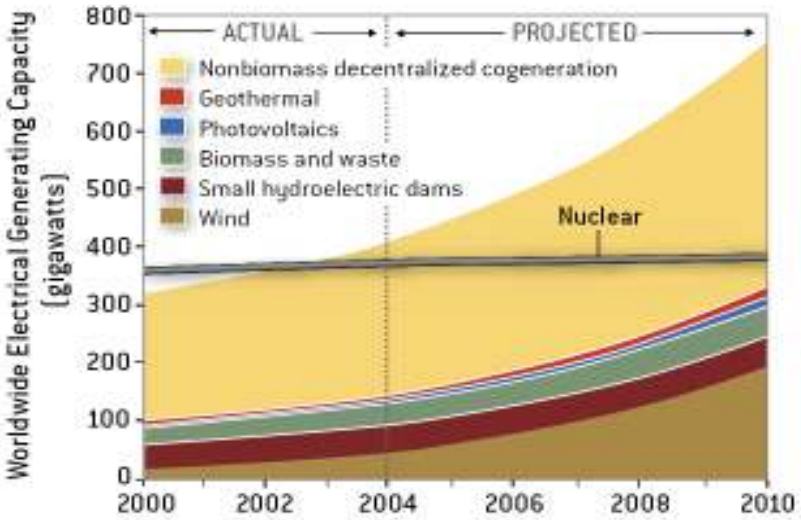

Figure 7.10. Decentralised sources of electricity surpassed nuclear power in global generating capacity in 2003. (Source: Rocky Mountain Institute, 2006)

7.3.5 Assumptions about the Costs of a Transition to a Low Carbon Transport Sector

Modern economies' transportation needs are remarkably dependant on oil and natural gas, and yet oil production has now peaked in over 60 countries (e.g. in the USA in 1972). Resources do not need to

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[162] 'Intelligent Energy – Europe' (EIE) is the Community's support program for non-technological actions in the field of energy, more specifically the field of energy efficiency and renewable energy sources. The duration of the program is from 2003-2006. The program was adopted by the European Parliament and the Council on 26 June 2003. It was published in the Official Journal of the European Union on 15 July 2003 (OJ, L 176, p 29-36) and entered into force on 4 August 2003.

[163] See the Lumina Project at http://light.lbl.gov/

run out in order to cause extra costs to the economy. In the case of metals, however, there are both many metals and numerous substitutes available in plastics and other materials thus ensuring that the market place can find cost effective alternatives relatively easily if any one metal becomes scarce. However, primary energy sources like oil are different. There are not, for instance, easy alternatives to oil for aeroplanes.

Since most experts warn that the rate of global oil production has, or is about to, peak, it is likely that oil prices will continue to be high over coming decades.[164] Many experts argue that this will result in historically high oil prices becoming a permanent fixture of the economic landscape. This threatens the global economy and business in three ways.

First, oil prices directly raise transport costs to business. Second, higher oil prices have an inflationary effect increasing the price of most goods and services and thus increasing purchasing costs to business. Higher oil prices have a strong inflationary effect causing the Reserve Bank to lift interest rates and thus making it harder for business to borrow and reducing consumer confidence and disposable income. Finally, high oil prices threaten countries balance of payments. Consider Australia as an example. Australia is already importing 50 percent of its oil, a figure set to reach 100 percent by 2020. By 2015, *"... imported oil would subtract about $30 billion a year from the Australian national export bill."*[165] Such a blow out in Australia's balance of payments deficit will leave the Australian Reserve Bank with little choice but to raise interest rates again to dampen local demand. The Australian economy's vulnerability to high oil prices makes the Australian economy vulnerable to recession.

Since 1965 there have been five peaks of world oil price, all of which were followed by economic recessions of varying degree. Former US Reserve Bank Governor Alan Greenspan has pointed out that "*All economic downturns in the US since 1973 have been preceded by sharp increases in the price of oil.*"[166]

Yet nations could rapidly decrease their dependency on oil, reduce greenhouse emissions and avoid a peak oil induced economic recession by

a) Rapidly shifting at least part of the domestic vehicle industry to manufacturing low emission vehicles.[167]

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[164] Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C., and Hargroves, S. (*2007 Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation,* The Natural Edge Project. Lecture 8.1: Designing a Sustainable Transport Future. Available At http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture8_1 Accessed 13. February 2008

[165] Senate Economics Committee (2005) *Incentives for petroleum exploration in Frontier areas*, Parliament of Australia, Chapter 3 - Schedule 5, p E12. Available at http://www.aph.gov.au/SEnate/committee/economics_ctte/tlab_7/report/c03.htm. Accessed 07.02.2008

[166] Porritt, J (2005) Capitalism As if The World Matters. *Earthscan Publishing*

[167] Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C., and Hargroves, S. (2007 *Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation,* The Natural Edge Project. Lecture 8.2: Integrated Approaches to Energy Efficiency and Alternative Transport Fuels – Car Vehicles Available at

b) Shifting to low emission, and cheaper, freight transport options. Wal-Mart in the USA, for instance, is investing in trucks with double the fuel efficiency of traditional trucks to both reduce greenhouse gas emission and reduce operational costs.[168]

c) Investing in faster national broadband coverage to bring down the costs of video-conferencing to reduce the need for so many interstate business meetings.

d) Reducing congestion costs, which currently cost the global economy US$100's of billions.

Investing in sustainable transport and urban design therefore is a wise investment yielding multiple benefits to improve quality of life and economic prosperity. Increasingly cities in OECD countries are pursuing this wisdom. Amsterdam has developed a diverse urban transport system, where nearly 40 percent of all trips within the city are taken by bicycle. Paris has a transport diversification plan that also includes a prominent role for the bicycle and is intended to reduce car traffic by 40 percent. London is relying on a congestion tax on cars entering the city centre and investing that money in sustainable transport infrastructure to attain a similar goal.

One of the reasons that OECD cities can rapidly shift to a lower carbon transport system with the right infrastructure and incentives is that at least 40 per cent of trips made in all OECD cities are five kilometers or less. Thus it is easy for such trips to be made by walking, cycling and or public transport if these are invested in. But it is not just OECD cities which can rapidly shift to becoming more sustainable. With oil prices reaching record highs, there is great interest currently from developing countries for ideas on how to meet local transportation needs without having to import and use ever increasing quantities of oil. Model sustainable cities in developing countries like Curitiba[169] in Brazil, and Bogota[170] in Columbia, are showing the way by demonstrating how sustainable transport - cycling, walking and buses – can comfortably manage over 70 per cent of all commutes, with better health and economic outcomes. 85 per cent of residents in Bogota now live within 500 metres of a bus service. Both Curitiba and Bogota achieved their sustainable transportation transformation within 10 years.

Investing in sustainable transport helps the economy in a wide range of ways which, to date, have been largely ignored by macro economic climate mitigation modelling. For instance, businesses which encourage staff to cycle and walk to work, are reported to benefit from increased productivity as a

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http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture8_2 Accessed 13. February 2008

[168] Smith, M., Hargroves, K., Stasinopoulos, P., Stephens, R., Desha, C., and Hargroves, S. (2007 *Energy Transformed: Sustainable Energy Solutions for Climate Change Mitigation*, The Natural Edge Project. Lecture 8.3: Integrated Approaches to Energy Efficiency and Alternative Transport Fuels - Trucking Available at http://www.naturaledgeproject.net/Sustainable_Energy_Solutions_Portfolio.aspx#EnergyTransformedLecture8_3 Accessed 13. February 2008

[169] Hawken, P. *et al* (1999) *Natural Capitalism: Creating the Next Industrial Revolution*. Earthscan. Chapter 14 Human Capitalism. Available At http://www.natcap.org/images/other/NCchapter14.pdf

[170] Runyan, C (2008) *Bogotá designs transportation for people, not cars*. World Resources Institute. Available at: http://archive.wri.org/newsroom/wrifeatures_text.cfm?ContentID=880

result of improved fitness and mental health.[171] Staff who cycle are reported to be more punctual and take less sick days.[172] One study has shown that absenteeism can be reduced from between 14% to 80% by encouraging cycling to work.[173] A 2005 study commissioned by Medibank Private in Australia found that healthy workers are almost three times more effective at work than unhealthy workers.[174]

Creating walkable cities, with safe cycling options and reliable public transport, thus could be a key strategy to encourage greater public health and combat spiralling health costs with an aging population. Australian Government health spending is projected to almost double by 2050 due in large part to the costs of diseases of physical inactivity – obesity, diabetes, cardiovascular - in an aging population. Paul Gross, from the Institute of Health Economics and Technology Assessment argues that for every dollar invested by Government in encouraging people to be active and live healthier lifestyles, the government would save six dollars in improved business productivity, reduced absenteeism and reduced drain on the health care dollar.[175]

To date, most economic cost benefit analyses on climate change, like the Stern Review, have ignored these additional costs and benefits to business from action on climate change. When additional issues, like health costs and benefits, reduced absenteeism, improved productivity are factored into the modelling then this significantly changes the economy wide return on investment of low carbon sustainable transport investments. The latest studies, which do factor in such hidden benefits, show that investing in sustainable transport options leads to higher economy growth than business as usual not less.[176]

It has long been believed that building roads is good for the economic growth of cities, while public transport is a financial drain. A 1999 report to the World Bank[177] prepared by researchers at Murdoch University is turning this way of thinking on its head. Professor Peter Newman says, 'We've found that cities which emphasise walking, cycling and public transport are healthier financially and spend less of their wealth on transport costs than those cities investing in freeways'. This conclusion is based on a global empirical study of over 90 cities and their transport systems. Other studies also cover in

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[171] Bicycle Victoria (2007) *The Cycle-Friendly Workplace*. Department of Health and Aging and the Department of Environment and Water Resources. Available At http://www.bv.com.au/file/file/RTW/BICY%20-%20Cycle-Fndly%20Workplaces_v12.pdf

[172] Queensland Transport and Main Roads (1999) *Cycle South East. Integrated Cycle Strategy for South East Queensland. Brisbane:* Queensland Government

[173] Shayler, M. *et.al* (1993) *Bikes Not Fumes: The emission and health benefits of a modal shift from motor vehicles to cycling*. Cyclist's Touring Club, Surrey

[174] Bicycle Victoria (2007) *The Cycle-Friendly Workplace. Department of Health and Aging and the Department of Environment and Water Resources* Bicycle Victoria. Available at http://www.bv.com.au/file/file/RTW/BICY%20-%20Cycle-Fndly%20Workplaces_v12.pdf Accessed 13. February 2008

[175] ABC (2006) The Costs of Obesity. ABC. Available At: http://www.abc.net.au/health/thepulse/s1587390.htm Accessed 7.02.2008

[176] Newman, P. and Kenworthy, J. (1999) *Sustainability and Cities*, Island Press, Washington, DC

[177] Ibid.

detail how OECD nations like the USA could reduce oil dependency rapidly. The Rocky Mountain Institute has released *Winning the Oil Endgame: Innovation for Profits, Jobs, and Security,*[178]a Pentagon co-funded blueprint for making the US oil-free. New technologies are becoming available which will help the global economy decouple transportation from greenhouse gas emissions. Gas-electric hybrid cars with an enhanced battery and a plug-in capacity, combined with investment in renewable energy feeding cheap electricity into the grid, permit most daily driving to be done with electricity, and at a cost equivalent of less than $1-a-gallon gasoline.

7.3.6 Assumptions about the Costs of Reducing non-CO2 Emissions

Economic modelling studies[179] indicate that a cost-effective abatement strategy would focus heavily on the non-CO_2 gases in the early years. This modelling also found that for smaller percent reductions, such as holding total GHG emissions in the US at year 2000 level through 2010, some of the most cost-effective cuts would come from the non-CO_2 gases. This economic modelling also found that the cost of an abatement policy, including the abatement options available for these non- CO_2 greenhouse gases, would be two-thirds less than the cost of achieving the same level of abatement by reducing CO_2 emissions from fossil fuels.

CO_2 is the largest contributor to climate change flowing from the GHGs emitted by human activity. Its relative role is expected to increase in the future. A continuing emphasis in economic modelling on the costs of reducing CO_2 emissions is therefore needed. But, if climate policies are to to effectively limit climate change, they must also take into account the importance of non-CO_2 greenhouse gases. As a result of improvements in recent years in the measurement and assessment of the non- CO_2 gases, it has become clear that their control is an essential part of a cost-effective climate policy. This applies particularly to developing countries where these gases typically account for a higher percentage of emissions. For example, non-CO_2 gases account for well over 50% of the GHG emissions in Brazil and India, but accouint for 20% in the United States and 29% in Australia.

There are five classes of greenhouse gases, other than CO_2, recognised by the Kyoto Protocol as causing global warming. These gases have significantly higher global warming potential than CO_2. For instance, sulphur hexafluoride (SF_6) has a global-warming potential 23,900 times higher than that of CO_2. Non-CO_2 greenhouse gases are also noteworthy for their very high global warming potentials and atmospheric lifetimes.

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[178] Lovins, A., Datta, E. K. and others. (2004) '*Winning the Oil Endgame: Innovation for Profits, Jobs, and Security'*, Rocky Mountain Institute, Colorado/Earthscan, London.

[179] Reilly, J. Jacoby, H. Prinn, R (2008) *Multi-Gas Contributors to Global Climate Change: Climate Impacts and Mitigation Costs of Non-CO2 Gases*. MIT. Available At http://www.pewclimate.org/global-warming-in-depth/all_reports/multi_gas_contributors

Table 7.2 The Six Major Greenhouse Gases.

Symbol	Name	Common sources	Atmospheric lifetime (years)*	Global warming potential	% of US emissions
CO_2	Carbon dioxide	Fossil fuel combustion, forest clearing, cement production, etc.	50-200	1	79.9
CH_4	Methane	Landfills, production and distribution of natural gas and petroleum, fermentation from the digestive system of livestock, rice cultivation, fossil fuel combustion, etc.	12	21X	9.5
N_2O	Nitrous oxide	Fossil fuel combustion, fertilisers, nylon production, manure, etc.	150	310X	5.8
HFCs	Hydrofluoro-carbons	Refrigeration gases, aluminium smelting, semiconductor manufacturing, etc.	264	Up to 11,700X	1.8
PFCs	Perfluoro-carbons	Aluminium production, semiconductor industry, etc.	10,000	Up to 9200X	
SF_6	Sulphur hexafluoride	Electrical transmission and distribution systems, circuit breakers, magnesium production, etc.	3,200	Up to 23,900X	
*Standard industry classification					

(Source: Energy Information Administration, (1998); IPCC, (2001))[180]

The indices or weights known as global warming potentials demonstrate the relative value of controlling non-CO_2 gases.This is one of the key reasons for including the non-CO_2 gases in policies to address climate change; for it can be so effective in lowering implementation costs, especially in the short term. A further reason is that, in the past, economic instruments such as prices, taxes and fees have not been used to discourage or reduce emissions of non-CO_2 gases but have, through the price signals of energy costs been present to curb fossil-fuel emissions. For instance the EU emissions trading scheme only began including the non- CO_2 gases in trading in 2008. Bearing in mind the high carbon-equivalent values of the non-CO_2 gases, even a small carbon-equivalent price on such gases could provide a large incentive to reduce emissions of them.

[180] Energy Information Administration (1998) Form EIA-846: Manufacturing energy consumption survey, and Form EIA-810: Monthly refinery report; Intergovernmental Panel on Climate Change (2001) Climate change 2001: the scientific basis, Cambridge University Press, 2001.

7.3.7 Assumptions about what Greenhouse Abatement is Possible through Clean Development Mechanism projects in a Post Kyoto Framework

Events in late 2007 at the UN Bali Summit give cause for hope that a Post Kyoto Framework will be agreed to internationally by the end of the period of the Kyoto Protocol agreement in 2012. Currently, under the existing Kyoto Protocol, there are incentives for OECD nations to invest in projects and initiatives which help developing countries to reduce their greenhouse gas emissions. All OECD countries which have ratified the Kyoto Protocol, can qualify for involvement in developing country projects under what is called the Clean Development Mechanism (CDM) – a scheme run by the U.N. Framework Convention on Climate Change to stimulate both improved and environmentally effective initiatives in developing nations through the provision of internationally-tradeable carbon credits.

CDM credits offer OECD nations another flexible way to cost effectively help their 2012 Kyoto Protocol targets. There is every reason to expect that a form of the CDM will continue under a Post Kyoto International Framework to assist both OECD and developing countries mitigate emissions as quickly as possible. Currently a wide range of potential projects qualify under the CDM. These are explained well elsewhere so this thesis will not cover them in detail here. But two comments are worth making.

First, most people do not realise that energy efficiency and conversion energy efficiency projects count as CDM projects. As outlined above in 7.3.2 there are many significant energy efficiency projects being undertaken in developing countries which are achieving significant results. These should provide inspiration for many more such effective programs to be duplicated in other developing countries around the world. Australian NGO, CoolNRG is already initiating projects to increase the uptake of millions of compact fluorescents in Mexico and China. These projects are being funded by Clean Development Mechanism credits. Improving coal-fired power stations' conversion efficiency in developing countries, for example, would count for CDM credits. In early March 2008, CSIRO announced that it had commenced a clean coal expertise partnership to assist China to equip its many coal power stations with greenhouse gas reducing technologies.

Secondly, if an OECD country compensates a developing country to stop deforestation of forests planted before 1990, this does not count under the Kyoto Protocol. Deforestation accounts for 18 per cent of global emissions, so it is likely that under the developing Post-Kyoto Framework, compensation schemes to stop large scale deforestation will count for CDM credits. The potential is significant in a post-Kyoto International Framework for OECD nations to be able to gain significant carbon credits whilst simultaneously developing countries earn income from preserving their forests. According to the Stern Review[181]and McKinsey the marginal cost per cut GHG abated from avoiding

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[181] Stern, N. (2006) *The Stern Review: The Economics of Climate Change, Chapter 9 Identifying the Costs of Mitigation*. Cambridge University Press, Cambridge. Available at pp244-247 http://www.hm-treasury.gov.uk/media/F/0/Chapter_9_Identifying_the_Costs_of_Mitigation.pdf

deforestation is the cheapest form of greenhouse abatement after energy efficiency. The Stern Review states

> Almost 20 per cent (8GtCO2/year) of total greenhouse gas emissions are currently from deforestation. A study commissioned for the Review looking at 8 countries responsible for 70 per cent of emissions from deforestation found that, based on the opportunity costs of the use of the land which would nolonger be available for agriculture if deforestation were avoided, emission savings from avoided deforestation could yield reductions in CO2 emissions for under $5/tCO2 possibly for as little as $1/tCO2."[182]

Given that, according to the McKinsey Global Institute, global emissions could be reduced by 20 per cent through energy efficiency, and up to 18 per cent through stopping deforestation, it could be possible, in theory, to achieve over 30 per cent global greenhouse gas reductions within a 5-10 year period just through these two strategies alone at negligible economic cost.

Since all OECD nations except the USA have ratified the Kyoto Protocol OECD nations and OECD business now have a wide range of low cost ways to gain additional carbon credits to count towards meeting both 2020 and 2050 GHG reduction targets.

7.3.8 Assumptions about how money from emissions credits is recycled and rebound effects.

A net gain in employment and increased GDP could result if the revenues from the money from selling emissions credits on greenhouse emissions were used to reduce payroll tax, or assist businesses in reducing their greenhouse emissions through targeting the most cost effective measures possible. But instead, to date, much of the economic modelling on the effect of emissions trading schemes on a nation's economy has assumed the resulting revenue stream to government will flow through the economy according to past priorities, rather than in ways that would be most beneficial, such as being targeted to help industry achieve energy efficiencies rapidly.

7.3.9 Assumptions about Rebound Effects

As discussed in Chapter 5, how governments manage rebound effects with effective policies significantly affects the size and nature of rebound effects and thus what economic models predict for the costs of mitigating climate change. The reader is referred to Chapter 5 for more details on this.

7.3.10 Assumptions about the Costs of Inaction on Climate Change

As discussed in Chapter 5, The Stern Review has been the first team to really try to estimate the costs of inaction on climate change in detail. The Stern Review found that

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[182] Stern, N. (2006) *The Stern Review: The Economics of Climate Change, Chapter 9 Identifying the Costs of Mitigation*. Cambridge University Press, Cambridge. Available at pp244-247 http://www.hm-treasury.gov.uk/media/F/0/Chapter_9_Identifying_the_Costs_of_Mitigation.pdf

> "If we don't act (on climate change), the overall costs and risks of climate change will be equivalent to losing at least 5 per cent of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20 per cent of GDP or more. In contrast, the costs of action – reducing greenhouse gas emissions is to avoid the worst impacts of climate change – can be limited to around 1 per cent of global GDP each year."

Historically many economists have underestimated or even ignored the costs of inaction on climate change. This was shown during the 2001 Australian Senate 'Heat is On' Enquiry'[183] A representative from the Australian Bureau of Agriculture and Resource Economics (ABARE), who are responsible for the main economic modelling used by the previous Australian Government was asked by Senator Bolkus and Dr Clive Hamilton why ABARE had assumed there would be no negative costs on the Australian economy from climate change? Ironically, Australia will be one of the most negatively effected economically by climate change if GHG reductions are not achieved rapidly enough. The Great Barrier Reef will be lost to bleaching within two decades.[184] If current trends continue

- In 2007, the Australian Bureau of Agriculture and Resource Economics (ABARE) has predicted that farm production could drop by 13-19 per cent by 2050, and Australian agricultural exports of key commodities are projected to decline by 11–63 per cent by 2030 and by 15–79 per cent by 2050 as the result of the effects of climate change.[185]
- High probability of at least a one meter sea level rise by 2100 negatively affecting the real estate market and businesses located on low lying coastal areas of Australia. Risks that such low lying areas will be difficult to insure in decades ahead.
- A dramatic rise in the number of summer days over 35 degrees by 2050 leading to loss of productivity at work due to the heat plus higher peak load electricity costs for business and industry. A dramatic rise in the number of summer days over 35 degrees will lead to rising peak load electricity demand.
- Higher probability and intensity of extreme weather events leading to greater risks of bushfires, hail storms, cyclones, droughts and floods.

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[183] Commonwealth of Australia, Official Committee Hansard, Senate Environment, Communications, Information Technology and the Arts References Committee, Roundtable Reference: Global warming Wednesday, 16 August 2000 Canberra by Authority of the Senate.

[184] Dayton, L. (2007) '*Reef Gone in 20 Years If Warming Continues'*, The Australian. Available at http://www.theaustralian.news.com.au/story/0,20867,21516991-601,00.html.. Accessed 13. February 2008

[185] ABARE (2007) Australian Commodities > vol. 14 no. 4 > December Quarter 2007. Available at http://www.abare.gov.au/publications_html/ac/ac_07/a1_dec.pdf Accessed 13. February 2008

7.4 Addressing the Vested Interests: Creating Anti Blocking Coalitions and A Movement for Change

To enable, politically and socially, a rapid transition to a low carbon economy, anti-blocking coalitions are needed to counteract the strong and powerful vested interests opposing rapid decoupling on greenhouse gas emissions.[186] It is also vital that everyone plays their part individually to reduce their emissions as our emissions from our homes and transport collectively are significant globally. But just as important to achieve lasting social and political change is that more people are aware of how they can collectively work for change to counteract the significant vested interests. Everyone has an opportunity to play their part here.

- First, anyone can become members of an environmental NGO which demonstrates to politicians that voters are seriously engaged with an issue. This helps enable environmental NGOs to more effectively lobby governments and business. Support for NGOs has been critical as NGOs since the early 1970s played a key role in ensuring even basic ideas like energy efficiency opportunities were taken seriously by business.
- Secondly, more and more local communities are committing and achieving large cuts to greenhouse gas emissions. Anyone can help share tips and information on how individuals can reduce their greenhouse gas emissions in their community to help bring about more systemic change. Such an approach over a decade resulted in Australia in the Renew magazine[187], which now reaches over 30,000 subscribers.[188] Local action has been important over the last four decades to demonstrate to people that it is possible to significantly reduce greenhouse gas emissions at the community level. Now in all capital cities and some country towns in Australia, solar house tours are run annually demonstrating this to communities.[189]
- Thirdly, those in environmentally orientated businesses can organise with other like-minded business leaders to form environmental industry groups and coalitions to lobby for change. This is increasingly occurring around the world. In November 2007 in the lead up to UN climate change negotiations in Bali, 150 of the worlds biggest corporations from around the world, including ANB AMRO, Philips, Sun Microsystems, Volkswagen, Johnson & Johnson, Tesco, Coco-Cola, Unilever, and Vodaphone, issued a remarkable statement – *The Bali Communiqué*[190] - calling for a comprehensive, legally binding United Nations framework to tackle climate change to underpin rapid reductions of greenhouse gas emissions in line with scientifically based targets. The process has been led by The Prince of Wales's UK and EU

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[186] Diesendorf, M (2007) *Greenhouse Solutions with Sustainable Energy*, UNSW Press, Sydney.

[187] See Renew Magazine at http://www.ata.org.au/publications/renew

[188] Diesendorf, M (2007) *Greenhouse Solutions with Sustainable Energy*, UNSW Press, Sydney

[189] See Australian Solar House Tour day at http://www.anzses.org/

[190] See *Bali Communiqué* at http://www.balicommunique.com/communique.html Accessed 13 February 2008

Corporate Leaders Groups on Climate Change, which is hosted by the University of Cambridge Programme for Industry.[191] *The Bali Communiqué* is significant in that its recommendations were based on its appreciation of the science rather than what is considered politically palatable or '*reasonable*'. In Australia, the environmental industry is represented by the Clean Energy Council and Environmental Business Australia.[192] In addition the National Business Leaders Forum for Sustainable Development provides a forum for pro-sustainable business leaders. All three organisations have undertaken a range of studies, published significant reports and make recommendations to government. All have played a role in moving the climate change debates forward in especially the Australian business community.

- Fourth, economists can help to debunk myths about the costs of action on climate change. In the USA[193]and Australia,[194] economists have come together and signed petitions to this effect, which has helped to shift the debates about the economics of climate change in these countries.[195]
- FIrth, since the poorest and most vulnerable on the planet will be the worst effected by climate change, churches and social justice organisations have increasingly chosen to take a stand on climate change on moral and ethical grounds. Any church or community organisation can help to disseminate information and provide a leadership role on the issue. If you are a member of a church or any community organisation you have an opportunity to help that community understand and take action on climate change.

Conclusion

There are a number of signs that action taken by individuals globally is starting to create a mass movement globally.

- Local and regional government around the world is showing significant leadership on climate change. Even in the USA, seven States, 227 cities and a number of influential members of Congress, both Republican and Democrat, have committed to emission reduction targets, renewable energy development and carbon trading. Anyone can lobby their local government to adopt targets for climate change reduction.
- Overdependence on oil and gas has resulted in a new impetus to reduce fossil fuel consumption. The widespread concern has resulted in a new group of advocates for energy security becoming proponents for climate change action.

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[191] See *Bali Communiqué* at http://www.balicommunique.com/communique.html Accessed 13 February 2008.

[192] See EnvironmentBusinessAustralia at www.eba.com.au

[193] See Economists' Letter on Global Warming: Endorsed by Over 2000 Economists including six Nobel Laureates: (http://uneco.org/Global_Warming.html#Economists'%20Letter%20on%20Global%20Wa).

[194] See Australian Economists: Government Must Ratify Kyoto at https://www.tai.org.au/?q=node/7&offset=3

[195] Diesendorf, M (2007) *Greenhouse Solutions with Sustainable Energy*, UNSW Press, Sydney

- Around the world, companies are using climate change to drive their business strategies to address not only emissions reductions, but also the development of technologies, new markets, and other areas of investment. Significant corporate activity to exploit the upsides of climate change is superseding what has been the prevailing view that reducing greenhouse gases harms economies and profits.
- A significant increase in the quantity and quality of media coverage around the world has brought climate change out of the scientific journals to the forefront of public awareness. In 2006 The New York Times and Washington Post alone ran nearly 600 stories on climate change. In 2006, the topic of global warming appeared on the cover of Time and the programs of the BBC, ABC (US), CNN and HBO. The substance of the articles moved from scientific queries to calls for action. Public awareness of the issue has increased as a result of this increased coverage.

These are positive signs, upon which much can be built and achieved. To help ensure this renewed momentum for action on climate change achieves meaningful results an overview of world's best practice on climate change policy and policy options are listed in Appendices 7.3-7.5