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Fighting climate change:
Human solidarity in a divided world

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Carbon Budget—the agenda for mitigation. Australia, Canada, the European Union and Japan

Caspar Henderson

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'When the world is changing very fast, I suggest survival may depend precisely on our ability to change rapidly in the face of changing conditions.' – Carl Sagan[i]

'The wealth of the world's rich countries has come largely as a result of cheap energy from fossil fuels, without realization of the damage being caused -- damage that is tending to fall disproportionately on poorer countries. There is therefore an inescapable moral imperative for wealthy countries: first, to take action to reduce drastically their emissions of carbon dioxide and, secondly, to use their wealth and skills to assist those in poorer countries to develop in sustainable ways.' – John Houghton[ii]

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Executive Summary

2007 is the 20th anniversary of the Brundtland Commission's influential report *Our Common Future*, which first put sustainable development on the international political agenda. Five years later the United Nations Framework Convention on Climate Change defined an effective response to the challenge of anthropogenic climate change as a central plank of sustainable development. Over the last fifteen years the global scientific community has demonstrated beyond all reasonable doubt regarding that it is necessary to radically curtail growth in greenhouse gas emissions and stabilize atmospheric concentrations at a much lower level than will occur if accepted projections of energy use prove accurate.

Most rich industrialized countries, including Canada, Japan and the countries of the European Union accepted an historic, legal and moral responsibility to act first to reduce emissions. To date, they have seldom kept their pledges. In order ensure that atmospheric concentrations of greenhouse gases do not rise above 400 to 450ppmvC02(e) by 2050 with reduction thereafter, these countries, and others, will need to cut their emission by 80% or more by that date.

This paper outlines the concept of carbon budgeting and the performance of the Australia, Canada, Japan and the European Union in managing and reducing emissions to date. It examines the strengths and weaknesses of some approaches to delivering greater emissions reductions, and identifies some policies for accelerating change in future.

1. An overview carbon budgeting

1.1. Context, definitions, key parameters

Anthropogenic climate change may present the greatest single challenge to human development in the 21st century and beyond[iii]. Emissions of greenhouse gases to date already commit the planet to significant climatic change, but some of the most severe future adverse impacts may be avoided if effective action is taken now and continuously for the next few decades. Such action must include steep reduction in emissions of greenhouse gases.

The United Nations Framework Convention on Climate Change commits its signatories to stabilize greenhouse gas concentrations in the atmosphere 'at a level that [will] prevent dangerous anthropogenic interference with the climate system.' Such a level should be achieved within a time frame sufficient:

- To allow ecosystems to adapt naturally to climate change
- To ensure that food production is not threatened and;
- To enable economic development to proceed in a sustainable manner.

All three of these conditions must be met if human development is to continue.

It has often been argued that dangerous climate change[iv], breaking at least one of these conditions, will occur if the average global temperature rises by more than 2 degrees Celsius[v] with regard to the pre-industrial average[vi]. The "carbon budget" is the total amount of carbon dioxide and other greenhouse gases[vii] that the world can emit without incurring a risk of exceeding this threshold that is agreed to be ethically and politically unacceptable[viii].

The size of that carbon budget is much contested. The scientific basis for any agreement between UN members is likely to be the work of the Intergovernmental Panel on Climate Change[ix]. In the summary for policy makers of the Fourth Assessment Report (AR4)[x], the IPCC sets[xi] the range of likely of climate equilibrium sensitivity for a doubling atmospheric concentrations of greenhouse gases[xii] at between 2 to 4.5°C, with a best estimate of 3°C. That is, they say there is greater than 66% probability[xiii] that the global average temperature will rise by more than 2°C (and a less than 5% probability it will rise by less than 1.5°C) for a doubling of carbon dioxide concentrations[xiv].

There are deductive and observational reasons for considering that the IPCC Fourth Assessment Report summary (AR4) understates the degree of risk. AR4 may, for example, underestimate positive feedbacks in the carbon cycle[xv] (and indeed the summary states that "values substantially higher than 4.5°C [for doubling of CO_2] cannot be excluded"). It may also be out of date because it omits recent observations such as the release of greenhouse gases, including methane, from thawing tundra[xvi] and more rapid rise in sea levels than has previously been predicted.

A study[xvii] commissioned for the UK government estimates that the atmospheric concentration of greenhouse gases would need to be stabilised at less than 450ppm CO_2 equivalent[xviii] in order to have a 60% chance of avoiding a rise in global average

temperature of more than 2°C. To have a 90% chance it may need to be stabilised as low as 400ppm CO_2e[xix]. Recommendations that concentration be limited to such a low level have been discounted the grounds that are unlikely to be achievable[xx]. It should be noted, however, that an atmospheric concentration of 450ppm CO_2e and even 400ppm CO_2e may still entail considerable risk of dangerous climate change[xxi], and is likely at the least to lead to climate change with high adaptation costs.

The gap between such a target and most projections is very large. On current trends, atmospheric concentrations may rise to 900ppmv or more this century[xxii]. To stabilise at 450ppmv or less would require very large changes in the way the world generates and uses energy. Many analysts, including those recommending radical action on climate change, consider such a goal to be close to unachievable[xxiii].

Leading climate scientists have issued stark warnings regarding the urgency of the need to reduce human impacts[xxiv]. "We have already passed the stage of dangerous climate change. The task now is to avoid catastrophic climate change" says John Holdren, President of the American Academy for the Advancement of Science[xxv]. "Recent greenhouse gas emissions place the Earth perilously close to dramatic climate change that could run out of our control, with great dangers for humans and other creatures", says James Hansen, head of the NASA Institute for Space Studies[xxvi].

1.2. Carbon budgeting for Australia, Canada, the European Union and Japan

How large is the global 'carbon budget' consistent with not exceeding an atmospheric concentration of 400 to 450 CO_2e? This cannot be determined precisely because, as noted above, there are uncertainties as to how the Earth's biogeochemical system reacts to rapid changes in atmospheric, ocean and terrestrial chemistry and temperature resulting from human activity[xxvii]. A quantum of direct anthropogenic emissions (from activities such as fossil fuel combustion and land use change) may cause an additional but uncertain and changing quantum of emissions from natural stocks such as forests, soils and oceans[xxviii]. This inherent uncertainty and risk supports the case for additional caution.

The IPCC's Fourth Assessment Report (AR4), a synthesis of the scientific knowledge available that is endorsed by all UN member states[xxix], says[xxx] that "to stabilise at 450ppm CO_2[xxxi] could require that cumulative emissions over the 21st century be reduced from approximately 607 [630 to 710] [Gigatonnes[xxxii] of carbon] to approximately 490 [375 to 600] GtC"[xxxiii].

To limit emissions to no more 490 GtC during the 21st Century may require cumulative emissions at the bottom of end of or even below the range envisaged under scenario B1 in the IPCC's Special Report on Emissions Scenarios[xxxiv]. That is, total global emissions would have to peak at no more than approximately 10GtC per year by about 2020 and begin to fall soon after 2030 to well under half (perhaps under a third) of current levels by the end of the 21st century.

At present total global emissions of carbon dioxide only from combustion of fossil fuels are estimated to be more than 7.4 GtC per year[xxxv],[xxxvi] Of these, more than 25%

are estimated to originate from the United States[xxxvii] and more than 24% from Australia, Canada, the European Union and Japan combined[xxxviii].

It should be noted that about 40% of the heat trapped by anthropogenic gases is due to gases other than carbon dioxide, primarily methane.[xxxix]

Historically, if not always today, the rich industrial countries are the biggest absolute emitters, and typically their emissions per capita remain far above the global average[xl]. Typically, too, these countries have the greatest capacity to invest and innovate[xli]. Many policy makers agree that low and middle-income nations, with more than four fifths of global population but accounting for only about half of total emissions from fossil fuel combustion, have a right to continue to increase their consumption of fossil fuels. Because there is little or no space for an increase in total global emissions without substantial increase in the risk of dangerous climate change, this means that the rich industrial countries must reduce their share of the total.

The current international framework offers a basis for greater emission cuts in future by nations that are already rich and industrialised even while many other nations increase their emissions at least in the short term. The United Nations Framework Convention on Climate Change[xlii], recognises the principle of "common but differentiated responsibilities,"[xliii] with greater responsibility for reducing greenhouse gas emissions in the near term on the part of the most industrialised countries (known as the Annex 1 countries[xliv]). The UNFCC itself is non-binding, but the Kyoto Protocol operationalises this principle, with cuts with respect to 1990 levels mandatory for some signatories to the Protocol that are Annex 1 countries [xlv], [xlvi].

In order to play a role[xlvii] in avoiding dangerous climate change, Australia, Canada, Japan and the countries of the European Union must (along with other rich industrialised nations) strongly intensify their commitments to reduce greenhouse gas emissions. A study[xlviii] published by the UK government indicates that by 2020 their [European Union?] emissions will need to be 25% below 1990 levels to be on track for stabilisation at 400ppm, and 15-20% below 1990 levels for stabilisation at 450ppm. By 2050 their emissions will need to be between 90% (for 400ppm) and 80% (for 450ppm) below 1990 levels.

Let us assume[xlix] total global emissions peaking at around 10GtC per annum from 2020 to 2030, declining to 7GtC in 2050 and 3GtC in 2100.

An 80% cut in 1990 emissions by Australia, Canada, Japan and the European Union would mean total net emissions per annum rom all these countries of 1,242 Million tonnes CO2 equivalent (see table 1), or 338.6 MtC(e)[l], which is approximately 5% of assumed total global emissions of 7GtC in 2050.

Table 1

a) net emissions (million tonnes CO2 equivalent)

	1990	2004	80% cut on 1990 level

Australia[li]	551.9	564.7	110.38
Canada[lii]	602	758	120.4
EU (25)[liii]	4000	3964	800
Japan[liv]	1059	1206	211.8

b) net emissions per capita (C02e)

Australia[lv]	30.66	28.23	6.13
Canada[lvi]	21.5	25.26	4.3
EU (25)	8.5	8.43	1.7
Japan	8.2	9.27	1.64

As noted above, in 2004 Australia, Canada, the European Union and Japan currently account for just over 24% of total global emissions of carbon dioxide from combustion of fossil fuels and approximately 10% of the global population[lvii]. By 2050 the proportion of the world's total population living in these countries is likely to be around 8%[lviii].

If total global emissions in 2050 are 7.5GtC per annum and world population is 9.4bn, then global [mean] per capita emissions will be 0.79tC or approximately 2.9tCO2 (that is, approximately 75% to current global average per capita emissions of 3.87tCO2). On this scenario, Europe and Japan would be significantly below the global [mean] per capita for the year 2050, but not necessarily the long-term historical average. (It is estimated, for example, that in 2007 Europe is responsible for 30% of anthropogenic greenhouse gases added to the atmosphere from the beginning of industrialisation until the present day[lix]).

2. Description of current structure of carbon emissions by sector, and trends

2.1. Overview

Australia, Canada, Japan and many of the major countries in the European Union have increased their emissions of carbon dioxide and other greenhouse gases significantly since 1990[lx]. All of these countries, with the exception of Australia, have committed to reductions under the Kyoto Protocol. Among the largest economies in this group discussed in this paper only two – Germany and the United Kingdom – are on track to meet their Kyoto targets. On current trends, almost all countries in this group are very far from achieving the kind of future cuts described in section 1 above[lxi].

Australia's net emissions increased by 2.3% between 1990 and 2004. (Emissions from fossil fuel combustion increased by some 34.7% but were offset by land use change etc). The country is expected to emit 21.8% more in 2010 than the target it would have had if had signed the Kyoto protocol, and its emissions for 2020 are projected to be 127% of the 1990 level. At present, Australia has by some margin the highest per capita emissions among the group of countries under discussion.

Canada's emissions increased by 27% between 1990 and 2005. Under the Kyoto Protocol, the country has agreed to a 6% cut on 1990 levels between 2008-2012. Its projected emissions for that period are 25.9% above its target.

Japan's emissions in 2005 were approximately 8.1% above their 1990 level. It is projected that it will exceed its Kyoto target by 11%. Under the Kyoto Protocol Japan has committed to reducing emissions by 6% in the 2008-2012 period[lxii]. Our research[lxiii] indicates that at the time of writing, official long-term projections for greenhouse gas emissions do not exist. However, in 2005 the Ministry for Economy, Trade and Industry produced cases (scenarios) as part a projection for energy and demand and supply to 2030. Its reference case ('business as usual') emissions are projected to rise to rise by about 13% above 1990 levels by 2020 and fall slightly to about 9% above 1990 levels by 2030. In its 'Energy Conservation Progress' case emissions are projected to fall to about the same as their 1990 levels in 2020 and about 10% below their 1990 levels by 2030. The Japanese National Institutes for Environmental Studies has argued that a 70% reduction in Japanese emissions could be achieved by 2050 at a cost of 1% of GDP. In May 2007 Japanese Prime Minister Shinzo Abe suggested a global target of a 50% reduction in emissions by 2050. Japanese officials said the reduction target was nonbinding and was a general 'vision' rather than an ironclad goal[lxiv].

For the European Union 25 (i.e. not including Bulgaria and Romania) total greenhouse gas emissions (not including emissions and removals from land use, land use change and forestry, or LULUCF), decreased by 4.8 % between 1990 and 2004[lxv]. But this figure hides significant differences between countries. Emissions by the EU's original 15 members[lxvi] are projected to be 0.6% below 1990 levels by 2010. The EU-15 countries are committed under the Kyoto protocol to an 8% cut on 1990 levels by 2008- 2012. Only 5 of the 15 are on track to meet their burden sharing targets. Greenhouse gas emissions have declined substantially in almost all new EU member states, mainly because of the restructuring or closure of heavily polluting and energy-intensive industries after 1989. In 2004, new member state emissions were 23 % below 1990 level. All new member states which have a Kyoto target were on track to meet their target.

Case study: The Swedish approach – a model for the rest of Europe?

In 2005 the Swedish government announced their intention to become the first country in the world to break their dependence on oil and other 'fossil fuel raw materials' by 2020[lxvii]. The government cited the threat of climate change as one of four key reasons for the policy[lxviii].

The announcement left environmentalists and others wondering whether larger countries in Europe, such as Germany, France and the UK, as well smaller ones such as Ireland[lxix], could follow a similar path.

Sweden has a big head start. Its electricity, for example, is already generated with next to no use of fossil fuels. Around half comes from hydropower and the remainder largely from nuclear. The UK, by contrast, already gets more than 70 per cent of its electricity from coal and gas, with less than five per cent from hydro and less than 20 per cent from nuclear. And with a land area nearly twice the size of the UK but home to one seventh the population, Sweden has far more space to produce biomass-mainly crops and wood-for conversion to fuels such as ethanol or for high temperature gasification and efficient combustion In 2005 the Swedish government announced their intention to become the first country in the world to 'break their dependence' on oil and other 'fossil fuel raw materials' by 2020. The government cited the threat of climate change of as one the key reasons for the policy, but identified four other key rationales for following this route: that it would secure Sweden's supply of energy in the long term; that would help Sweden become a leading nation in the development of new technology for sustainable use of energy and more efficient use of energy; that it would strengthen international economic competitiveness; and that it would use and develop the country's rich energy resources from forests and fields.

In 2006 a newly appointed national Commission on Oil Independence published a strategy for achieving this goal, titled *Making Sweden an Oil-Free Society*[lxx]. The Commission proposed as national objectives that:

• Swedish society as a whole should be able to make 20 per cent more efficient use of energy by 2020 and thereby at the same time create intensified, cost-effective prosperity that is sustainable in the long term
• By 2020 in principle no oil should be used for heating residential and commercial buildings
• Road transport, including transport in the agricultural, forestry, fisheries and building sectors, should reduce use of petrol and diesel by 40-50 per cent by 2020
• Industry should reduce its use of oil by 25-40 per cent by 2020

The Commission stressed that despite the inclusion of the worlds 'Oil-Free' in the title of its report, was 'to reduce as far as possible actual consumption of oil by the year 2020'…and 'to reduce the one-sided dependence on oil in areas where total independence from oil will take much longer to achieve, for example in the transport sector'. It also proposed the development of 'models, control instruments and concrete measures' to reduce dependence coal and natural gas as well.

Central to the Swedish strategy are the twin agendas to improve efficiency in energy use across all sectors ('Radically more effective use of energy by the whole of society') and rapid upscaling in the production and use biofuels and biopower from forest and agricultural land ('Historic investment in forest fuels and energy crops'). The Commission also proposed a thorough review of electricity generation, including increased domestic production from renewable resources and enhanced demand management measures, and strategic investment in energy gases derived from biomass. It also identifies 'control instruments at EU level' as crucial for Sweden's

continued competitiveness: the Europe wide ceiling for the number of emission rights needs to be gradually lowered.

The ambition and scope of the Swedish approach has attracted considerable attention and admirers around the world. But its example should be seen in perspective. Few countries enjoy a similar combination of advantages, including a highly advanced knowledge-rich economy, well developed co-operation between government, business and society, and abundant resources for biofuels (Sweden and Finland the largest acreage of woodland per inhabitant in the European Union). And – with the programme less than a year old at the time of writing – Sweden is yet to demonstrate concrete progress towards its new goals.

2.2. Power

There is notable divergence with regard to trends and projections from the electrical power sector among the countries included in this study

Australian power sector emissions increased by 43% between 1990 and 2004, from 195.7 to 279.9 MT CO_2e

Canadian power sector emissions increase

EU power sector emissions

Japanese power sector emissions

Case study: German Feed in Law[lxxi]

Since at least the 1970s many have advocated more widespread deployment of renewable energy technologies such as wind and solar power as a solution to security and environmental challenges. In practice these technologies have often remained at the margin of the energy production, contributing little more than one or two per cent of energy demand in the large industrial economies.

This track record has reinforced a widely held perception that renewables will remain peripheral, and that nuclear power and the continued use of fossil fuels such as coal (with the addition of carbon capture and storage) remain essential to wealth generation in the 21st century is necessary.

But the experience of Germany (the world's biggest exporter, the third largest economy in US$ exchange rate terms, the fifth largest by purchasing power parity and the largest economy in Europe) from the late 1990s to date indicates that this perception is misplaced. A set of policies centring on what are known as 'feed-in tariffs' (FITs) have enabled a rapid uptake of new renewable energy to the point where in 2006 they supplied nearly 12% of total gross electricity demand and 5.3% of total primary energy consumption, accounting for €21.6 billion (US$29bn) total

turnover and €8.7 billion ($11.7bn) worth of investment that year.

The history of FITs in Germany shows how a gradual, trial-and-error approach to renewables can accelerate the deployment of new clean technologies despite well entrenched opposition from powerful industrial-political lobbies for coal, lignite and other more established energy technologies.

Feed in tariffs place a legal obligation on utilities to purchase electricity from renewable energy installations. Typically, the tariff rate is guaranteed for a period of up to 20 years and determined for each technology to ensure profitable operation of the installation. The costs are shared among all end-users so that no-one is overly burdened.

Renewable energy technologies developed thanks to the favourable economic and regulatory climate created by feed-in tariffs have generated billions of dollars a year in German exports, created nearly a quarter of a million jobs and saved 97 million tonnes of CO2 in 2006. It has also set records for installed capacity across many renewable technologies at the cost to date of around €1.50 ($1.80) per household per month.

Some thirty countries (but not yet the US, Japan or the UK) are now following the German model, though with differences in detail of the way the law is designed. One example is tariff 'degression' so that a new renewable energy technology such as photovoltaics (PV) gets a lower tariff rate if installed some years hence rather than this year or next. This encourages swift take-up and encourages manufacturers to increase design efficiency on the principle that if you going to receive a lower rate, you want to generate more electricity. This drives innovation.[lxxii]

2.3. Transport

2.3.1. Overview

Emissions from transport have, in most cases, been rising faster than any other sector in the world's mature industrial economies. This is likely to present one of the greatest challenges to a drive to reduce emissions. Vehicle fleet average fuel efficiency is increasing very slowly, while targets set for biofuel consumption are likely to make little if any contribution to emission reduction in the short and medium term, and without policy changes could have significant adverse impacts. Aviation and shipping both presents significant challenges if greenhouse gas emissions are to be cut. The emissions from these sectors are not included in national reporting or international mechanisms.

Australian transport emissions increased by 23.4% between 1990 and 2004, from 61.7 to 76.2 $MtCO_2e$

Canadian transport emissions accounted for 28% of the total increase in national emissions between 1990 and 2004 – an additional 44 $MtCO_2e$ raising the total to 197$MtCO_2e$.

European Union transport emissions grew by 32% between 1990 and 2004 (increasing their share of total emissions from 21% in 1990 to 28% by 2004)[lxxiii]. This makes transport the worst performing sector and seriously jeopardises the achievement of the European Union's Kyoto targets. Even in 10 new member states which joined the Union in 2004 (and where emissions overall fell sharply with economic restructuring after the fall of communism), emissions from transport in 2004 exceeded 1990 levels by 28 %.

Japanese transport emissions increased by 18.1% between 1990 and 2005, from 217 to 257 $MtCO_2e$

2.3.2. Cars in the European Union

Emissions from 'light duty vehicles' (passenger cars and vans) are responsible for approximately half of EU transport emissions. The benefits of increased efficiency are clear. For example, cutting average new car emissions in the EU from the 2005 average of 162grams of carbon dioxide per kilometre to 120g/km by 2012, as was originally envisaged, would reduce car CO2 emissions 11% – that is, more than 5% of all emissions from transport (not including aviation), and up to 2% of total EU emissions. An EU voluntary agreement with automobile manufacturers was supposed to reduce average new car emissions from 186g in 1998 to 140g by 2008. By 2005 this was off course, with emissions averaging 162g/km.

In January 2007, following pressure from the EU auto industry and the German government, the European Commission set looser emissions limits for new cars. The commission voted in favour on proposals to impose a mandatory CO2 emissions limit of 130g per km on all new cars from 2012 (*check*). Its original plan to set the target at 120g had bee shelved last week after a vigorous dispute[lxxiv].

In February 2007 EU country energy ministers agreed to increase the share of biofuels used in transport to 10% by 2020. The move was opposed by many civil society groups, who argued that the target be likely to lead to an *increase* in actual net emissions and would undermine the European Union's commitment to sustainable development[lxxv]. (see box on fuels in section 2.4 below)

Three-quarters of the 20 major car brands sold in Europe in 2005 to improve fuel efficiency at the rate needed to meet a key EU climate target[lxxvi].

There is evidence that automakers exaggerate compliance costs for safety or environmental regulation by 2 to 10 times actual cost (e.g. seat belts, catalytic converters, air bags).

2.3.3. Aviation

Worldwide, commercial aviation is growing by 5% a year while the projected improvement in jetliner fuel efficiency is 2% or less per year. Most analysts agree that

there is unlikely to be a viable alternative to jet fuel (kerosene) in the years up to 2050[lxxvii]. Aviation is excluded from international inventories of greenhouse gases for the Kyoto Protocol.

The Intergovernmental Panel on Climate Change concluded that pollution from high-flying jets is up to four times as damaging to the environment as the same amount released by chimneys and other exhaust pipes at ground level[lxxviii].

The Advisory Council for Aeronautics Research in Europe, a body made up of representatives from industry, government, and academia, has launched what it calls a strategy that includes halving carbon dioxide emissions and reducing nitrogen oxide emissions by 80%, but ACARE envisages no timetable for these goals, saying only that the cuts will come some time beyond 2020.

Some commercial organisations point Virgin airlines plans to invest $3bn in developing ecologically friendly plant-based jet fuel. Ethanol weighs 60% more per unit volume than kerosene, and you need 64% more volume to get the same energy. An ethanol fuelled 737 would need a 25% larger wing and engines with 50% more thrust just to get airborne. In 2002, Britain's Royal Commission on Environmental Pollution concluded that because of such problems, aeroplanes will continue to rely on kerosene for at least 40 years[lxxix].

Hydrogen doesn't generate carbon dioxide but it provides only one quarter as much energy as the same volume of kerosene so the fuel tanks would have to be four times as large to carry a hydrogen fuelled plane the same distance. Hydrogen also produces about three times as much water vapour as kerosene when it burns. Above 9000m – where airliners spend most of their time – this would create larger contrails which in turn form cirrus clouds that contribute to global warming.

Increased efficiency will created some benefits, but even on the most optimistic scenarios these are most unlikely to alter the upward trajectory of emissions to less than 3% per year. If countries are to reduce their total emissions of greenhouse gases they will have to 1) take account of aircraft emissions in their national totals; and 2) choose whether to limit those emissions by putting caps on air travel or making equivalent cuts elsewhere through mechanisms such as carbon trading (see section 5 below).

Box: UK aviation

The United Kingdom generates more flights than any other European country. A fifth of all international passengers worldwide are on flights that arrive or leave from UK airports. Growth in aviation is considered essential to UK prosperity. Emissions from aviation are omitted in UK reporting of its greenhouse emissions.

There has been fierce debate in the UK over how much the impact of emissions from aviation. Industry figures put the figure at around 2% but this appears to be the global average rather than an accurate figure for the UK. A more generally accepted figure is around 5.5%[lxxx] [reference]. This does not, however, take account of the fact that emissions by aircraft have a greater impact – three to four times as much forcing –

compared to emissions at ground level. If the generally accepted figure of 5.5% is multiplied by 3 to account for forcing from nitrous oxide and water vapour then the actual contribution of aviation to the impact of UK emissions on the climate may now closer to 18%.

UK emissions from aviation doubled between 1990 and 2000. During the same period, the combined emissions of carbon dioxides from all other UK activities fell by approximately 9%. Most forecasts indicate that UK aviation emissions will more than double again between 2000 and 2030, and could increase to between 4 and 10 times their 1990 level by 2050 on a "business as usual" trend.

Even at the lower end of the forecast range, carbon dioxide emissions from aviation are set to reach 17MtC (62.39 $MtCO_2$) by 2050. The higher end of the range is 44MtC (161.48 $MtCO_2$). The UK has a target to reduce its carbon emissions from all activities by 60% from 1990 levels to 65MtC (238.55 $MtCO_2$) by 2050. These growth forecasts already allow for improvements that may be achieved through changes in air traffic management, other operation procedures and technological development. If these do not occur emissions could be even higher. Thus, the UK will be unable to meet its targets for reducing climate change impacts without decisive action to curb the demand for air travel.

Most of the recent expansion in air travel has occurred because people with higher incomes are flying more often. The greatest growth has been in international leisure flights, which now outnumber business flights made by UK residents by five to one. The UK is increasingly developing an air dependent culture. If action to tackle flying is postponed, says critics of current policy, Britain will enter an era in which frequent flying is increasingly the norm for better-off households, with lifestyles adapted to this expectation.

Aviation does bring economic benefits, including employment, and these would be impacted if future growth were curbed. But, say critics of current policy, this would be offset by public revenue from a more appropriate fiscal package for aviation and the potential effect of higher airfares on the UK's growing tourism deficit, which stands at £17bn; for every £1 an overseas visitor spends in the UK, a UK resident spends £2.32 abroad[lxxxi].

2.2.4. Shipping

Greenhouse gas emissions from shipping are thought to be double those of aviation and increasing fast. At present they are in the range 600 to 800m $MtCO_2$, or 4 to 5% of the global total. This is nearly double the UK's, total emissions and more than all African countries combined. It is estimated they could grow by up to 75% in the next 15 to 20 years if world trade continues to grow as projected and no action is taken to improve energy efficiency. Carbon dioxide emissions from ships do not come under the Kyoto agreement or any proposed European legislation[lxxxii].

2.3. Industry and other

Australian emissions from industrial processes increased by 18% between 1990 and 2004 from 25.3 to 29.8 $MtCO_2e$. Emissions from the waste sector decreased by 0.7% from 19.2 to 19.1 $MtCO_2e$

Canada – non-energy industrial emissions accounted for 18% of the total in 2004 (136.4 $MtCO_2e$), a slight decrease on 1990 levels.

Japanese emissions from industrial processes decreased by 3.2% between 1990 and 2005, from 482 to 466 $MtCO_2e$

European Union emissions from industrial processes.

Case Study – Canadian oil and gas sector[lxxxiii]

A 67% increase in GHG emissions from the oil and gas sector accounted for one-third of Canada's total increase in emissions between 1990 and 2004.

Energy production is one of the cornerstones of the Canadian economy. Roughly 40% of Canada's greenhouse gas production is associated with the production and distribution of energy for domestic use and for export[lxxxiv]. Oil and gas represents over 90% percent of Canadian energy exports. Canada is currently the largest foreign supplier of oil to the United States. Growth in the oil and gas sector since 1990 has helped drive the record growth in the Canadian economy and the increase in GHG emissions.

The primary reason is the development of the tar sands or oil sands in Alberta. Oil sands are a mixture of sand, silt, water, clay and bitumen, a thick tar-like mix of hydrocarbons. The bitumen deposits in three regions of northern Alberta – Athabasca, Cold Lake and Peace River – together may represent the largest known reserve of extractable oil on the planet. Unlike conventional oil, however, the highly viscous bitumen is not recoverable through wells. Instead, it must be extracted either by more costly and energy-intensive methods like mining or in-situ methods like underground steam heating[lxxxv].

The mining method, responsible for 61% of current extraction in Canada (2006 data[lxxxvi]), involves stripping away the overlying layers of soil and directly removing the oil sands. The in situ methods involve removing the bitumen from the sands underground. The most common approach, used in 28% of extraction, is to add steam heat to the underlying sands. This makes the bitumen less viscous, allowing it to flow to the well. After extraction, the majority of the separated bitumen is then upgraded to create synthetic crude oil. The synthetic crude can be upgraded by refineries into transportation fuel or other products.

Development in the Alberta oil sands first began in 1960s. It did not expand until the 1990s, when the depletion of other oil reserves, the availability of natural gas to drive extraction and higher oil price made development more attractive and cost-efficient. From 1996 to 2004, $34 billion was spent on new projects[lxxxvii]. By May 2006, oil sands projects accounted for 62% of all major projects listed by the Economic Development department of the Alberta Government[lxxxviii]. The Canadian Association of Petroleum Producers and the Canadian National Energy Board estimates that

roughly $95 billion will be spent in construction of oil sands operations from 2006-2016, including capital expenditures and money to sustain capital. Total output from the oil sands was 1.1 million barrels per day in 2005 and is expected to at least triple by 2015. With a decline in conventional oil production, the oil sands are expected to represent 80% of Canada's oil production by 2020[lxxxix].

The challenge for producers is the energy-intensive extracting, refining and processing the oil from the oil sands currently can generate anywhere two to four times the GHG emissions of conventional oil drilling. The rapid development in the oil sands is the prime reason that GHG emission from the oil and gas sector increased by more than 50% from 1990 to 2004 and that Alberta surpassed Ontario as the largest emitting province. For example, 79% of emissions of Suncor, Inc, one of largest oil and gas firms in Canada, now come from its oil sands operations[xc]. Continued oil sands development is expected to account for 41-47% of national emissions growth to 2010[xci]. The GHG emission from the oil sands could increase by three to five times by 2020[xcii].

The economic opportunity in the oil sands has led the oil and gas industry in Canada and the province of Alberta to oppose binding national GHG emissions targets in the past[xciii]. However, Canada's Auditor General recently indicated that the federal government must identify targets for GHG emissions reductions from oil and gas and develop an implementation plan[xciv]. The increasing capital expenditure in the carbon-intensive oil sands is expected to be one of the central challenges in achieving long-term emissions reductions in Canada. Since oil sands projects are expected to have a lifespan of 30 years or more, current and planned investments could commit Canada to continued emissions growth.

The best opportunity for mitigating emissions from the oil sands without harming the economy may be the development of carbon capture and storage (CCS) technology. Multiple levels of governments and energy corporations have begun supporting demonstration projects that capture CO_2 generated during the extraction process in Alberta and inject into geological reservoirs. An ongoing international storage and monitoring project in an oil field in Weyburn, Saskatchewan is currently the largest carbon sequestration project in the world. The technology is potentially attractive to energy companies operating in western Canada because the injected CO_2 could enhance oil recovery. While current CCS projects have produced negligible emissions reduction (at the national level), they have indicated the potential for expansion. One obstacle in will be developing a pipeline to rout CO_2 from its source in the Alberta to the ideal locations for geological storage in neighbouring Saskatchewan.

An emissions policy centered on CCS technology could eventually help Canada achieve carbon-neutral growth[xcv]. One study estimated that oil sands activities could become carbon-neutral by 2020 through investing in CCS, improving energy efficiency, switching to low-carbon fuels (e.g. biofuels) to drive extraction processes, and purchasing offsets[xcvi]. The cost was estimated a 2-14 US$ per barrel of oil, which could be acceptable if oil prices remain high[xcvii]. A potential means for funding development of CCS technology would be requiring foreign purchasers of energy from the oil sands to also fund offsetting emissions from the extraction and production process.

Case Study – Spanish construction sector[xcviii]

Among Annex I countries, Spain has experienced the second largest increase in GHG emissions since 1990[xcix]. This trend largely reflect the overall improved socio-economic situation in Spain during the 1990s which was characterized by strong economic growth, a construction boom (150,000 new buildings every year), an increase in the size of houses, an increase in the overall use of domestic electrical appliances, the introduction of domestic central heating systems, and the resulting continuously increasing demand for electricity consumption, including significant additional energy demands resulting from tourism.

The main measures in the residential, commercial and institutional sectors are related to the normative preparation and regulation process to obtain more efficiency and energetic savings in new and existing buildings. Among those rules it has to be emphasized those linked with the 2002/91/CE Directive about energetic efficiency of buildings, with are specified in the Technical Code of Buildings (Código Técnico de la Edificación), the overhaul of the Regulation for Thermal Installations of Buildings (Reglamento de Instalaciones Térmicas de los Edificios), and the Energetic Certification of Buildings (Certificación Energética de Edificios). The Action Plan 2005-2007 of the Energy Efficiency Strategy for Spain sets measures to reduce the energetic costs, focusing in three sub sectors: construction, public services, and residential and IT equipment. These measures promote the increase of the energetic efficiency of buildings, particularly those of new construction, as well as the public lighting, installations for water cleaning processing and a plan for the updating of electrical appliances stimulating the use of efficient equipment in new buildings and in the public administration.

The Technical Code of Buildings establishes three strategic measures:

1. Renovation of thermal envelope of existing buildings and limiting energy demand for new buildings.
2. Improvement of energetic efficiency of existing heating, lighting and air – conditioning systems.
3. Use of PV solar energy to produce electricity.

The implementation of such measures may result in up to a 40% saving for each building and a CO2 emission reduction of up to 55%[c].

The energy labeling of buildings is also part of the 2002/91/CE directive. Such initiative enables users to know the energetic performance and characteristics of new built buildings. Such information aims to set a market and add value to those buildings with high energetic efficiency and, thus, promote investments in energy saving during the construction process.

2.4. Agriculture, Land Use, Land Use Change and Forestry

Australian emissions from agriculture increased by 2.2% between 1990 and 2004 from 91.1 to 93.1 MT CO_2e. Australian emissions from LULUCF decreased by 72.5% over the same period from 128.9 to 35.5 MT CO_2e

Canada figures are sought

European Union figures are sought

Japan figures are sought

Biofuels

Biofuels are often seen as a major constituent part of a sustainable global energy economy, especially for the rapidly growing transport sector. In the influential 'wedges' analysis by S. Pacala and R. Socolow[ci], one of the fifteen potential 'wedges' judged capable of reducing global emissions by 1GtC, is 'biomass [in place of] fossil fuel'. The European Union and its member governments are among those[cii] pressing ahead with ambitious targets for increased biofuels consumption, with each member state to achieve at least 5.75% biofuel usage of all vehicle traffic by 2010 and 10% by 2020[ciii]. But such policies could well prove counterproductive unless and until policies are reformed and there are significant technological breakthroughs.

One of the main concerns about rapid increase in biofuel production and consumption is that it will require large amounts of valuable agricultural land and scarce water. At present, Germany uses about 12% of its cultivated land for biofuel crops to produce just 2% of the transport fuel it consumes [check]. Pacala and Socolow suggest that to reduce global emissions by 1GtC, two billion 60mpg cars would need to run on 100% biofuels by 2050. Using current technologies, this would require 100 times current Brazil or US ethanol production on 250 million hectares, or one-sixth, of the world's cropland. For current technology, the majority of new land coming under cultivation for biofuels to meet growing demand is likely to be in the global south, thanks to typical pr advantage is enormous. Combined with growing concern that climate change will reduce availability of cultivatable land in vulnerable regions[civ], increased demand for biofuels could increase pressure on scarce water supplies[cv] in some regions and on vulnerable tropical habitats.

Other concerns are that, contrary to claims by industry and government, the current generation of biofuels may make little contribution to emission reductions compared to other investments[cvi], and could even lead to substantial *increases* in the release of greenhouse gases to the atmosphere. In northern regions such as Europe and North America, current production methods achieve a 'net energy value' that is only narrowly positive – that is, you only get out 20 to 30% more energy than you put in[cvii]. The net energy value from crops such as sugar cane and palm oil grown in tropical regions is better, other things being equal. But rapidly rising demand for biofuel in Europe and other industrialized countries could, it is feared, increase pressure for deforestation and other forms of land use change that lead to high emissions of greenhouse gases and are also damaging in other ways. One study indicates that greenhouse gas emissions per unit energy combusted in a vehicle engine are up to ten times higher for palm oil grown on tropical forest or peat land that has

been cleared for the purpose than they are for fossil fuels[cviii]. Other concerns[cix] include a rapid increase in very poor conditions for agricultural workers, and negative impacts on biodiversity in remaining areas of high endemism.

New techniques, such as cellulosic biomass by microbial 'metabolic engineering', may produce biofuels fuels from undifferentiated biomass, requiring much less land and far lower energy inputs. Researchers say the full potential of cellulosic ethanol may be obtained in the next 10 to 15 years[cx]. But even if this prediction proves correct there is still likely to be a period of 10 to 20 years in which the world will continue to depend on current biofuel technologies. If the critics are correct, targets and incentives to increase consumption during this period may lead to increased emissions of greenhouse gases.

3. Critical analysis of carbon target setting and underlying policy framework

3.1. Overview

The governments in Canada, Japan, and the countries of the European Union (EU) accepted a responsibility to be first movers in greenhouse gas emission reductions when they ratified the Kyoto Protocol[cxi]. Canada and Japan remained pledged to their Kyoto targets, but are far off trend for meeting these targets, and have not set anything in place beyond 2008-2012.

The EU as a whole may miss its Kyoto target, but not by as much as Canada and Japan. It has also promised to go further, with a pledge to reduce emissions by 20% by 2020, and more if other countries agree to similar reductions[cxii].

The government of Australia has refused to sign the Kyoto Protocol or set any targets for actual emission reduction, but has taken a range of steps to increase the efficiency with which energy is used in the economy.

3.2. Australia[cxiii]

Australian industry has consistently argued that the Australian government should only pursue policies that are flexible and cost-effective in their own right, and that have the least negative impact on competitiveness, investment, regional development and jobs[cxiv]. This lobbying[cxv], allied to the heavy dependence of the Australian economy on the mining and minerals industries, has strongly influenced the Australian government's approach to both international negotiations and domestic policy.

While it has continued to play an active role in the international processes around the United Nations Framework Convention on Climate Change (UNFCCC)[cxvi] and the Kyoto Protocol, the Australian government has actively sought to work with other countries – in particular, the United States – to develop alternative international approaches to the target-based approach of the Kyoto Protocol. Perhaps the most significant activity in this regard has been the leadership role played by Australia in

establishing, along with the United States, China, Japan, India and the Republic of Korea, the Asia–Pacific Partnership on Clean Development and Climate in 2005. The aim of the partnership is to develop global agreements on climate change based on clean technology development and deployment rather than the emissions target approach used in the Kyoto Protocol[cxvii]. In addition, Australia works with six bilateral climate change partners - China, the United States, New Zealand, Japan, the European Union, South Africa - on practical cooperative projects responding to global climate change. More than 50 projects in areas such as renewable energy, coal mine methane capture, energy efficiency, and carbon sequestration are now under way through these partnerships[cxviii]. Australia also participates in four multilateral partnerships that focus on technology: the Renewable Energy and Energy Efficiency Partnership, the Methane to Markets Partnership, the International Partnership on the Hydrogen Economy and the Carbon Sequestration Leadership Forum.

Australia has adopted a range of policy measures at the Commonwealth, State and Territory, and local government levels directed at reducing greenhouse gas emissions. At the Commonwealth level, the emphasis has been on 'no regrets measures', where a no regrets measure is defined as 'a measure that has other net benefits (or, at least, no net costs) besides limiting greenhouse gas emissions or conserving or enhancing greenhouse gas sinks'[cxix]. That is, the emphasis of policy has been on encouraging Australian industry to contribute to reducing greenhouse gas emissions while not threatening Australia's international competitiveness[cxx].

Despite the focus on no regrets measures, the Commonwealth government has committed around 2 billion dollars (Australian) to greenhouse issues since 1997[cxxi]. The Commonwealth government's Climate Change Strategy[cxxii] incorporates a mix of policy measures including consumer and corporate education, voluntary corporate participation in emission reduction activities, seed funding for renewable energy innovations, mandatory standards for power generation, energy-use efficiency and vehicle fuel efficiency, the mandatory uptake of new renewable energy in power supply, research and policy development into sinks and emissions, and fostering growth in plantation forestry and native vegetation. These measures are projected to deliver greenhouse emissions abatement of 87 MT CO_2(eq) by 2010[cxxiii]

Some of the key policy measures that have been adopted include[cxxiv]:

- The Greenhouse Gas Abatement Programme[cxxv] which is designed to leverage private sector investment in activities or technologies that will result in substantial reductions in greenhouse gas emissions or sink enhancement, particularly in the Kyoto target period (2008–2012).
- The Greenhouse Challenge Plus (discussed as case study in section 4 below)
- The A$500 million Low Emissions Technology Demonstration Fund which will operate from 2005–2020 to support the demonstration of new low-emission technologies with significant long-term greenhouse abatement potential, and to support industry-led projects to demonstrate the commercial viability of new technologies or processes, or the application of overseas technologies or processes to Australian circumstances. The fund aims to leverage at least A$1 billion in contributions from the corporate sector.
- The Mandatory Renewable Energy Target which will secure 9,500 Gigawatt-hours of additional renewable energy electricity by 2010. In addition, the

Commonwealth Government has various programmes to support the commercialisation and use of renewable energy technologies.

- The Solar Cities programme which will provide $75 million over nine years (2004–2013) to demonstrate the costs and benefits of solar power, energy efficiency and smart metering technologies.
- The Greenhouse Action in Regional Australia programme which aims to coordinate greenhouse action across the land sectors and build the capacity of the agriculture and land management sectors to reduce greenhouse gas emissions by promoting forest sink enhancement and the integration of forest sinks and greenhouse issues with natural resource management.

One of the most significant influences on Australia's greenhouse gas emissions has been the introduction of a wholesale electricity market across Australia, which has increased the carbon intensity of electricity generation (through favouring low cost brown coal power producers)[cxxvi]. The Commonwealth government has acted to address (at least partially) this market failure by requiring electricity suppliers and large purchasers to increase the quantity of renewable energy purchased by 2 per cent by 2010[cxxvii], as well as providing funding for the commercialisation of renewable energy technologies. Market liberalisation has also led to reductions in energy prices in real terms for most consumers in most regions. The relatively low price of electricity in Australia has been a barrier to effective demand side management; in Australia, the rate of improvement in end use energy efficiency in Australia over the past decade has been about half the OECD average[cxxviii].

While most current policy measures are directed at allowing Australia to meet its Kyoto Protocol commitments, a number of the measures (e.g. the Low Emissions Technology Demonstration Fund, the Solar Cities trial, a $100 million Renewable Energy Development Initiative) seek to deliver greenhouse gas abatement options beyond the Kyoto compliance period. Notwithstanding these measures, Australia's greenhouse gas emissions are expected to be 127% of the 1990 level by 2020.

In parallel to the Commonwealth government's activities, each State and Territory has established a greenhouse strategy to address those issues with a bearing on climate change – for example, waste management, the planning and development of power plants, land use and transport planning and vegetation management - that fall under its jurisdiction[cxxix]. There are two noteworthy features of the State and Territory policy frameworks. The first is that a number have acknowledged the need for significant cuts in greenhouse gas emissions in order to avert the most serious effects of climate change. For example, Victoria has suggested that it will need to reduce its emissions by 75% of current levels, with substantial progress towards this goal required in the first half of the 21st century[cxxx]. Similarly, New South Wales has set a target of reducing greenhouse gas emissions by 60% by 2050[cxxxi]. In contrast, the Commonwealth government which has not set targets beyond the Kyoto Protocol compliance period of 2008-2012.

The second is that the States and Territories have taken a strong lead on the issue of emissions trading[cxxxii], despite the Commonwealth government emphasising that it will not introduce emissions trading in the absence of an international emissions trading scheme. In January 2004, the First Ministers of State and Territory Governments established a working group of senior officials (subsequently named the

National Emissions Trading Taskforce) to develop a model for a national emissions trading scheme[cxxxiii]. The group issued a public discussion paper in August 2006 on the possible design of such a scheme[cxxxiv]. The paper suggests that national emissions trading could begin by 2010, but it is too early to gauge how influential this activity will be, given the Commonwealth government's strong opposition to the idea of emissions trading.

The structure of the Australian economy – in particular the dependence on the mining and minerals industry and on access to low cost energy – has been the key influence on Australia's approach to international climate change negotiations and to domestic policy.

While Australia expects to meet its Kyoto Protocol compliance commitments, this is primarily due to the significant emissions reductions from the land use, land use change and forestry sector. Otherwise, Australia's greenhouse gas emissions have grown significantly ahead of its Kyoto Protocol targets. Beyond 2012, Australia expects its greenhouse gas emissions to grow significantly (by approximately 27% over 1990 levels through to 2020).

The public policy measures that have been adopted to date are consistent with Australia's desire not to disadvantage its businesses. The major policy approaches have been voluntary measures such as the Greenhouse Challenge programme and significant financial support or subsidies for renewable and cleaner energy. As yet, the Australian government has not implemented the stronger policy measures, for example, emissions trading, necessary to direct the Australian economy towards significant reductions in its greenhouse gas emissions.

The lack of policy certainty or clear targets beyond 2012 and the absence of a 'price' for carbon represent key barriers to the investments – for example, in clean coal - necessary to significantly reduce Australia's greenhouse emissions. In order to remove these barriers, the Commonwealth government needs to signal its commitment to significant reductions in greenhouse gas emissions over the next 30 to 50 years, and commence the implementation of the policy measures – in particular emissions trading and prioritising energy efficiency in the electricity generation sector - to deliver on this commitment.

3.3. Canada[cxxxv]

In the 1997 Kyoto Protocol, Canada agreed to reduce GHG emissions by 6% below 1990 levels by the 2008-2012 commitment period. The Kyoto Protocol was not officially ratified until December 17, 2002, due in large part to concerns of opposition parties in Parliament and Alberta and other provinces that the failure of the US to ratify Kyoto would hurt Canada's competitiveness[cxxxvi]. The delay in ratification slowed development of a federal implementation plan. The first thorough plan for meeting the Kyoto target was released in late 2002, around the time of ratification.

The 2002 Climate Change Plan for Canada called for meeting the national Kyoto target by 2010 through purchasing of offsets from other nations, credits for exports of clean energy, credits for forestry practices ("sinks") and a variety of new and existing programs[cxxxvii]. The new programs included a emissions cap and trade system for

large final emitters or LFEs – heavy industry including oil and gas, mining, manufacturing and electricity generation – that are responsible for almost half of the domestic GHG emissions. Other emissions cuts were expected to come from voluntary initiatives like the One Tonne Challenge, begun in 2004, which promoted ways the average Canadian could reduce their personal greenhouse gas emissions by 20% or one tonne.

On April 13, 2005 the federal government released a *Project Green*, an updated plan to meet the projected 270 Mt gap between business-as-usual emissions in 2010 and the Kyoto target[cxxxviii]. The core of the updated policy was:

- A $4-5 billion federal "Climate Fund" which would be used to purchase domestic and international offsets, including clean energy, co-generation of energy from industry, carbon sequestration projects and capture of landfill gas
- A $2-3 billion partnership fund to support emissions reduction by the provinces and the private sector, including carbon capture and storage and clean coal technology.
- A updated cap and trade system for the LFEs, in which targets were based on emissions intensity rather than total emissions.

The plan was criticized[cxxxix] for reliance of voluntary measures, including a voluntary agreement with the large automotive sector[cxl] and emissions offsets. The LFEs were responsible for only one-eighth of the burden for the emissions reductions, and they could comply by purchasing carbon offsets or investing in a technology fund, rather than reducing actual emissions. A recent report by Canada's Auditor General, a watchdog for federal government policies, concluded that the national climate change plan was "not well organized and not well managed" and lacked "leadership, planning and performance"[cxli].

In January of 2006, a new minority government led by the Conservative Party assumed power and cancelled all federal climate change programs stating the Kyoto target was impossible to achieve with so little time. In the fall, the government released a new Clean Air Act that called for a 45-65% reduction in GHG emissions below 2003 levels by 2050, but contained no specific policies and no binding targets before 2020[cxlii]. Recent initiatives before the Canadian Parliament and political pressure have led to a review of the Clean Air Act[cxliii] and may force government to develop a new policy that complies with public demand for a climate change mitigation policy[cxliv].

A new policy with both short-term and long-term targets and a specific prescription for meeting at least a fraction of the Kyoto target is the most likely outcome of the current political unrest. One example, a plan released by Stéphane Dion, leader of the opposition Liberal party and Environment Minister under the previous government, pledges to meet the Kyoto target through the *Project Green* programs, public financing for energy efficiency improvements, expansion of wind power and other renewable energies, and reduction of tax breaks for development in the Alberta oil sands[cxlv]. The plan also endorses the need for a binding long-term target for emissions reduction target (e.g., 60% below 1990 levels by 2050) and automotive fuel efficiency.

3.4. Japan[cxlvi]

The first concern for the Japanese government is to meet its commitments under the Kyoto Protocol. The Kyoto Protocol Achievement Plan released by the Japanese Government in April 2005 spells out targets for all sectors[cxlvii].

It is important, however, to note that the targets in the Achievement Plan are described as "orientational/indicative targets", and are not backed up by any obligatory measures or potential sanctions. The Kyoto Protocol Achievement Plan includes a lengthy description of measures to be taken both by key sectors/stakeholders and by the government, but there is no over-arching policy instrument to ensure the actual implementation of such measures by key players in society.

In July 2006 the Ministry of the Environment released a progress report on the Achievement Plan, stating it would be necessary both to strengthen present measures and introduce new, additional policy tools to meet Japan's Kyoto Target. The progress report does not describe in any great detail comprehensive or over-arching policy tools (such as an EU-like cap-and-trade system or environmental taxation), but points to thirteen major areas in which a strengthening of present measures could have significant impact, defined as a reduction potential of more than 10 million tonnes of CO_2 per area by 2010. The thirteen areas are:

(1) Realization and further strengthening of [Keidanren's] Voluntary Environmental Action Plan (see case study in section 4.3. below). Reduction potential: 42.4 $MtCO_2$ by 2010.
(2) Improvement of energy efficiency in buildings. An accelerated plan for energy efficiency improvement could yield a reduction of 25.5 $MtCO_2CO_2$ by 2010.
(3) Further promotion of Building Energy Management Systems and Home Energy Management Systems.
Reduction potential: 11.2 $MtCO_2$ by 2010.
(4) Improvement of energy efficiency in houses. An accelerated plan for energy efficiency improvement could yield a reduction of 8.5 $MtCO_2$ by 2010.
(5) Further promoting nuclear power (and increasing operational efficiency of nuclear power plants) and other measures to lower CO_2 emissions in electricity production. Reduction potential: 17 $MtCO_2$by 2010.
(6) Promotion of new energy sources (in particular solar and biomass). Reduction potential: 46.9 $MtCO_2$ by 2010.
(7) Promotion of co-generation equipment and the use of fuel cells. Reduction potential: 11.4 $MtCO_2$by 2010.
(8) Further acceleration of top-runner program [see below] for the improvement of vehicle fuel efficiency. Through the natural replacement of inefficient vehicles with more efficient vehicles and through further technological and policy measures to continue fuel efficiency improvements, a reduction of 21.13 $MtCO_2$ is possible by 2010.
(9) Further acceleration and broader introduction of top-runner approach to electric appliances. Through the natural replacement of electrical appliances as well as the introduction of the top-runner approach to a wider range of appliances, including microwave ovens, rice cookers, gas-based grill devices, etc.) a reduction of 29.01 $MtCO_2$ is possible by 2010.

(10) Systematic promotion of new materials in industry, in particular non-freon aerosols, non-freon polystyrene, SF6-free magnesium alloys, etc. Reduction potential: 43.6 $MtCO_2$ by 2010.
(11) The recovery of HFCs used as coolant in automobiles and other devices (in accordance with existing legislation). Reduction potential: 12.38 $MtCO_2$ by 2010.
(12) Replanting and better maintenance of forests/forestry. Reduction potential: 47.67 $MtCO_2$ by 2010[cxlviii].
(13) Purchase of 100 million tonnes CERs (certified emissions reductions) between 2006-2013 under the Kyoto Mechanism[cxlix].

The Achievement Plan is under continuous revision as of early 2007, and a first draft report on potential additional measures is expected in March, 2007. It is expected that additional budget measures will be proposed by summer 2007 and finalized around December 2007, following the Japanese budget cycle. Talks with officials from both the Ministry of Environment and the Ministry of Economy, Trade and Industry in January 2007, however, indicate that as of early 2007, "nothing has been decided." It is not clear what specific measures will be taken to close the significant gap existing between Japan's Kyoto Target and actual emissions (as indicated above, the gap reached 14.1% as of end of 2005).

3.5. The European Union

The European Union has endorsed an objective for all developed countries to make a 30% cut in greenhouse gas emissions with respect to 1990 levels by 2020, and has made what it calls a 'firm independent commitment' to a cut its own emissions by 20% by that date. It also says that all developed countries should work with a view to cuts of 60% to 80% by 2050[cl]. This position puts it ahead of any other developed country or group of developed countries.

One of the biggest challenges, however, is likely to be showing that the EU can actually achieve its own interim commitment for 2020. As Peter Sutherland, chair of BP and chair of a group of wise mean appointed to advises the European Commission on energy observed, 'What we don't want to see is the agreement at the council turning into Lisbon agenda mark two in terms of massive aspiration and failed delivery'[cli].

The combination of projected increases in energy demand in many sectors (especially transport), and the need to take account of emissions that have not previously been counted (such as aviation and shipping) mean that the 20% reduction target is likely to remain challenging.

Some analysts express concern that what should be the primary goal – emission reduction – may be side-tracked as more effort goes towards goals that are secondary to actual emission reduction. One example is an EU-wide renewable energy target (of 20% from renewables by 2020) Some entities may also press for ways to keep emissions from certain sectors 'off balance' (not recorded in national totals).

Case Study: Climate change policy – is the UK really the leader of the pack?

The UK government says it is on track to double emission cuts required under the

Kyoto Protocol. But there are signs of increasing difficulty ahead. UK emissions rose by 1.25% in 2006, thanks in part to increased coal combustion[cliii].

In March 2007 the United Kingdom government published draft Climate Change Bill which aims to put in place a framework to achieve a mandatory 60% cut in the UK's carbon by 2050 compared to 1990 levels, with an intermediate target of between 26% and 32% by 2020. If approved, the UK is likely to become the first country to require such a long-range and significant carbon reduction target in law.

But an independent audit of the UK's actual climate change policies[cliii] predicts that the government will fail to meet its interim target for 2020 by some margin. It projects that the true reduction on will be between 12 and 17%.

The 30% cut by 2020 relative to 1990 levels is a self-imposed government target that goes beyond the UK's obligations under the Kyoto protocol. The UCL team's 12 to 17% figure is based on downgrading the predictions considering the likely effects of policies.

For example, the government predicts that national transport emissions will rise by 4m tonnes MtCO_2. But this assumes that car manufacturers deliver on voluntary fuel efficiency targets. Such milestones have never been hit. The team also believes the government's projections for the number of car journey's in 2020 are an underestimate. The report predicts that emissions from national transport will actually rise by between 7m and 13m tonnes.

In the domestic energy sector, one much-trumpeted government policy is a set of new building regulations to make all new homes built after 2016 ‘zero carbon’. However, the UCL auditors are sceptical that this policy will deliver because of poor enforcement.

The researchers also believe domestic energy consumption will continue to rise faster than the government predicts due to demand for more energy intensive products, such as plasma televisions[cliv].

An analysis of the Climate Change Bill by researchers at the Tyndall Centre[clv] says:

- The atmospheric concentrations implied by the logic of the Bill are upwards of 600ppmv CO_2, and could well be in excess of 750ppmv CO_2.
- The targets are more likely to contribute to a world 4°C or 5°C warmer than pre-industrial, than they are to constrain warming to no more than 2°C.
- The carbon reduction targets within the Draft Bill should be re-visited, be evidence based and be in keeping with the latest IPCC science on the subject.
- All Government reference to targets, temperatures and concentrations should be informed by a clear understanding of the science and of the ‘correlation trail’ between temperature and emission pathways.
- The Bill should provide joined-up climate change legislation in which emissions from *all* sectors are factored into the emission pathway. However, even with the Bill’s current neglect of aviation and shipping, the emission pathway it describes correlates approximately with an 80% and 60% chance of *exceeding* 2°C and 3°C warming respectively.

4. Critical analysis of industry and corporate initiatives

4.1. Overview

There has been a broad range of responses from major corporations (in the extractive industries, manufacturing, finance, retail and other sectors) with operations in Australia, Canada, Japan and the countries of the European Union to pressure for emissions reductions. While few now dispute the science of climate change and the need in principle for economies as a whole to reduce emissions, many corporations, especially in energy-intensive sectors, favour voluntary rather than mandatory approaches for their own sectors (see section 2.3.2 above). Where cap-and-trade systems are in place, many corporations have pressed successfully for free right rights to emit as against having to pay, through auctions or other mechanisms, for this valuable and scare resource (see section 5 below for a focus on cap and trade).

For an increasing number of corporate players, climate change is seen through the lens of risks and/or opportunities. Some major players in insurance and finance, for example, have called for strong and early action to manage the risk of climate change, with unambiguous commitment from government and long term targets for emission reduction., And in a few sectors, such as venture capital, renewable energy and energy service firms see market opportunities in the challenges ahead. Some industries see a competitive advantage in 'eco-efficiency'.

4.2. Obfuscation or co-operation

Early corporate responses to climate change can be put into two broad categories: those seeking to challenge the scientific consensus and the need for mandatory action to reduce emissions; and those which accept the science and the need for action and seek to shape the terms on which action is taken.

The most notable example in the first category was probably the US-based Global Climate Coalition, created in 1989 by the US oil and automotive industries and the National Association of Manufacturers to oppose mandatory actions to address global warming. (Many GCC members had a significant presence in Australia, Canada, the European Union and Japan). In 1997, following intensive lobbying and advertising by the GCC, the US Senate overwhelmingly passed a resolution against ratifying the Kyoto Protocol[clvi]. In 2002 the GCC considered its work in the US against regulation on global warming to have been so successful that it 'deactivated' itself. Some major corporations quit the GCC to join groups such as the Pew Center on Global Climate Change and other non-partisan initiatives which see climate change as a serious challenge. Obfuscatory activities have, however, continued[clvii].

In the second category are groups such as the World Business Council for Sustainable Development, created in 1995, which describes its mission as 'to provide business leadership as a catalyst for change toward sustainable development'[clviii]. A recent

WBCSD publication envisages establishing by 2020 a 'pathway for the management of global greenhouse gas emissions'[clix]. Another example is the 3C initiative[clx], which 'aims [to form] a global opinion group consisting of companies showing leadership by demanding an integration of climate issues into the world of markets and trade facilitated by means of a global framework coming into force in 2013'[clxi]. Also in early 2007, a group of representatives from major companies, trade bodies and other organizations[clxii] calling themselves the Global Roundtable on Climate Change endorsed what they called a 'bold post-Kyoto framework for affecting change at the levels of policy and industry, particularly in regard to creating sustainable energy systems necessary for achieving economic growth'[clxiii].

4.3. Eco-efficiency and risk management

Many companies have favoured an emphasis on eco-efficiency – 'doing more with less'[clxiv]. This approach can lead to substantial emission reductions[clxv], but sometimes these are not as great as they may appear. GE, for example, has stressed that its 'Ecomagination' approach will reduce the company's 'greenhouse gas intensity' (the quantity emitted per unit of economic activity) by 30%, but has placed less emphasis on projections that because of company growth the actual resulting emission reductions are likely to be on the order of 1%.

Increased clarity and pressure for disclosure from the finance and insurance sectors and from civil society, is tending to drive change. Examples from the insurance industry include Swiss Re, the world's second largest reinsurance company, which in 2004 estimated that the economic costs of climate-related disasters threatened to reach $150 billion a year within ten years. In 2006 Lloyd's of London published a report highlighting the latest science and implications for the insurance industry[clxvi]. A leading initiative supported by investors is the Carbon Disclosure Project[clxvii], which says its web site is 'the largest registry of corporate greenhouse gas emissions in the world'[clxviii]. The CDP is supported by 280 institutional investors with assets of more than $41 trillion[clxix].

4.4. A way forward

With greater certainty regarding the science thanks to the IPCC's Fourth Assessment Report, and increasing understanding of the costs of *not* tackling climate change (thanks in large part to the Stern Review of the Economics of Climate Change[clxx]), the business sector is more ready than before to accept limits on greenhouse gas emissions. Many recognized new commercial opportunities in emission reductions[clxxi].

The business case for responsible action on climate change has been one in principle. The challenge of enforcement remains[clxxii]. So long as *all* emissions from corporate activity are taken into account, and not just the ones some companies would wish to highlight, the corporate sector can benefit its bottom line, its shareholders, all nations and the planet.

Case Study 1 – the Japanese Voluntary Action Plan[clxxiii]

The backbone of Japanese industry's climate change mitigation measures is the "Voluntary Action Plan" first established by Nippon Keidanren, Japan Business Federation, in 1997 - the year of the Kyoto Conference. Seven major industry associations (electronics, steel and metals, oil and gas, mining, trade, construction, and chemicals) work with their individual corporate members to meet targets set in the Voluntary Action Plan. Industrial emissions from these seven industry groups account for 90% of total industrial emissions in Japan[clxxiv].

The overall target set in 1997 was to reduce emissions in 2010 to the 1990 level. Targets set in the voluntary action plan, thus, do not relate directly to the Kyoto Protocol, nor are there any sanctions for corporations who fail to meet targets. As of early 2007, this target (1990 level emissions) was achieved, or estimated to be achievable, in most industries, and in total emissions from the industrial sector were some 3.2% below 1990 level by end of 2005 (preliminary figures).

One major problem with this voluntary plan is that corporations are free to set targets either as absolute reduction targets or as efficiency targets relative to sales or energy usage. As a result of this, there is no uniformity in target setting, with some industries setting multiple targets, some focusing on reduction targets relative to sales, some relative to energy usage, and some committing to absolute emissions reductions.

In March 2005, the Central Environment Council, under the auspices of the Ministry of the Environment, recommended that the Japanese government should urge Nippon Keidanren to work with the Council and the Ministry of the Environment to ensure that the targets set in the Voluntary Action Plan are met, and to strive for further emissions reductions where possible. On the basis of this recommendation, a "follow-up" process commenced with seven industry working groups set up by Nippon Keidanren. In December 2006, these working groups reported to the Central Environment Council on achievements and further potential reduction measures were discussed. This process has not yet reached its conclusion as of February 2007.

The Japanese Government in the Kyoto Protocol Achievement Plan released in April 2005, encourages an 8.6% reduction of CO_2 by 2010 (as compared to 1990) from the industrial sector. It is unclear how the gap between Nippon Keidanren's zero target (or from the actual reduction level on 3.2% by 2005) to the Government's 8.6% reduction requirement is to be bridged. Nippon Keidanren has not made any public announcements that its members are willing to go beyond the goal of keeping 2010 emissions at 1990 levels

Case Study 2 – Australia's Greenhouse Challenge and Greenhouse Challenge Plus[clxxv]

The Commonwealth of Australia government established the Greenhouse Challenge in 1995 as a voluntary programme for public and private sector organisations to undertake and report on their actions to abate greenhouse gas emissions. The aim was

to achieve the maximum practicable greenhouse gas emissions abatement, while not compromising business objectives such as development and growth[1].

Organisations wishing to participate in the Greenhouse Challenge were required to work through a six-step process, namely establishing and maintaining an inventory of greenhouse gas emissions, developing an action plan to minimise greenhouse gas emissions or enhance greenhouse sinks, forecasting expected reductions in greenhouse gas emissions, signing a Cooperative Agreement with the Commonwealth government[2], monitoring and reporting on greenhouse gas emissions against targets, and being open to independent verification. The Greenhouse Challenge did not involve specific abatement targets being imposed on participating organisations, nor were there any sanctions or penalties where forecasts were not achieved.

In May 2004, the Australian government announced budget funding of A$31.6 million for the Greenhouse Plus – Enhanced Industry Partnerships measure (hereafter the Greenhouse Challenge Plus). The Greenhouse Challenge Plus builds on the infrastructure and existing commitments of the Greenhouse Challenge[3], with the Cooperative Agreements signed under the Greenhouse Challenge being carried forward into Greenhouse Challenge Plus[4]. Participants' commitments are broadly similar to those under the Greenhouse Challenge; participants are required to measure and monitor their greenhouse gas emissions, deliver the maximum practicable greenhouse gas abatement, continuously improve the management of greenhouse gas emissions and sinks, work towards the milestones set in individual agreements, provide annual reports to the Australian Greenhouse Office, make a public statement about participation in the programme, promote industry participants' activities and participate in independent verification of annual progress reports[5]. The annual progress reports are expected to include an updated emissions inventory, a statement of absolute changes in emissions, a statement of progress against significant abatement actions, changes in emissions intensity, details of the calculation methodologies and assumptions used, an indication of which elements of the report are not confidential and a sign off by the chief executive or authorised delegate[6].

From 1 July 2006, participation in Greenhouse Challenge Plus is a mandatory

[1] Howard (1997) (Note **Error! Bookmark not defined.**).

[2] Cooperative Agreements were expected to include an emissions inventory, an assessment of the opportunities available for abating greenhouse gas emissions, a greenhouse action plan, and a commitment to regular monitoring and reporting of performance. Cooperative Agreements can be viewed at http://www.greenhouse..gov.au/cgi-bin/challenge/dbsearch.p1

[3] Greenhouse Challenge Plus will also provide the framework for Greenhouse Friendly certification (a voluntary initiative that provides Australian businesses with the opportunity to market 'greenhouse-neutral' products or services) and the Generator Efficiency Standards programme (which aims to aim to achieve best practice in the efficiency of electricity generation).

[4] AGO (2005b), 'Greenhouse Challenge Plus: Programme Framework 2005' (AGO, Canberra, 2005).

[5] AGO (2005b) (Note 4).

[6] AGO (2005b) (Note 4).

[7] AGO (2005c), 'Greenhouse Challenge Plus: An Australian Government-Industry Partnership to Reduce Greenhouse Gas Emissions and Improve Energy Efficiency (AGO, Canberra).
[8] AGO (2005c) (Note 7).
[9] AGO (2005b) (Note 4).
[10] AGO (2005b) (Note 4).
[11] AGO (2005d), 'Australia's Response to Climate Change' (AGO, Canberra).
[12] For a current list of members, see: http:www.greenhouse.gov.au/challenge/members/pubs/list_of_challengers.pdf. It was envisaged that 500 companies would have signed Cooperative Agreements by the end of 2000 and that 1000 companies would have signed by the end of 2005. The AGO has stated that the mandatory requirements to join the Greenhouse Challenge Plus mean that the government's target of 1000 Greenhouse Challenge members by 2005 is no longer a useful target or indicator of progress (AGO (2004b), *AGO Annual Report 2003/2004* (AGO, Canberra) at 27).
[13] See, for example, Australian Industry Greenhouse Network (AIGN) (2005), 'Submission on Greenhouse Plus: Industry Consultation Discussion Paper' (AIGN, Melbourne).
[14] Sullivan, R. (2005), *Rethinking Voluntary Approaches in Environmental Policy* (Edward Elgar, Cheltenham) at 120-122.
[15] Sullivan, R. and Sullivan, J. (2005), 'Environmental Management Systems and their Influence on Corporate Responses to Climate Change', in Begg, K., van der Woerd, F. and Levy, D. (eds.) (2005), *The Business of Climate Change: Corporate Responses to Kyoto* (Greenleaf Publishing, Sheffield), pp. 117-130 at 122. In the data that are available, there is limited evidence that the organisations participating in the Greenhouse Challenge went beyond a narrowly defined interpretation of the costs and benefits of greenhouse gas emission reduction measures. The majority of the projects implemented were either low cost projects or projects that provided very short payback periods. In this context, the Greenhouse Challenge can be said to have been economically efficient in that it did not require firms to implement measures beyond those that could be clearly justified in economic terms. A more critical conclusion could be that the Greenhouse Challenge did not provide the strong drivers necessary to encourage companies to take advantage of all the opportunities that might be available (Sullivan (2005) (Note 14) at 115-117).
[16] For a more detailed discussion of the emissions performance of Greenhouse Challenge participants, see Sullivan (2005) (Note 14) at 110-115.
[17] It has been argued that many of the 'easy' emissions reduction measures (the 'low hanging fruit') have now been implemented and it will become ever more difficult to achieve reductions without incurring economic penalties (Allen Consulting Group (2000), *Meeting the Kyoto Target: Impact on Regional Australia. Report by the Allen Consulting Group for the Minerals Council of Australia* (Allen Consulting Group, Melbourne)).
[18] Sullivan (2005) (Note 14) at 123-125.
[19] National Audit Office (2004), *The Administration of Major Programs: Australian Greenhouse Office* (National Audit Office, Canberra) at 43, 70.
[20] National Audit Office (2004) (Note 19) at 82.
[21] See also Sullivan, R. and Ormerod, R. (2002), 'The Australian Greenhouse Challenge: Lessons Learned and Future Directions for Climate Policy', in Albrecht, J.

requirement for Australian companies receiving fuel excise credits of more than A$3 million and for the proponents of large energy projects[7]. The AGO has estimated that these new requirements will affect around 100-200 businesses[8], although it is likely that many will previously have been members of the Greenhouse Challenge.

The programme allows participants to be recognised as Greenhouse Challenge Plus Leaders if they publicly disclose their gross emission levels, their short-term goals for greenhouse, an overview of their climate change strategy and the expected direction of future greenhouse gas emissions and mitigating actions[9]. In addition, they are expected to develop action plans to meet or exceed their annual greenhouse goals, to reference best practice in the development of greenhouse targets and key performance indicators, and to encourage their suppliers to take greenhouse actions[10].

The actions taken under the Greenhouse Challenge Plus programme are expected to contribute more than 15 MT CO_2(eq) in greenhouse gas emissions reductions in 2010[11].

Outcomes from the Greenhouse Challenge

The Greenhouse Challenge has formed the centrepiece of the Australian government's efforts to encourage business to take action on greenhouse gas emissions and climate change for over ten years. Over 750 companies were members as at the end of 2006[12] and the programme had significant coverage of Australian greenhouse gas emissions with almost total coverage in a number of major industrial sectors, including electricity generation and distribution, oil and gas extraction, iron and steel and aluminium, and coal mining.

The flexibility provisions in the Greenhouse Challenge were supported by industry as enabling cost-effective approaches to greenhouse gas emissions abatement to be implemented[13], and the programme has provided a range of important soft effects, in

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(ed.) (2002), *Instruments for Climate Policy* (Edward Elgar, Cheltenham), pp. 170-191 at 184-187

[22] For a more detailed assessment of the potential contribution of Greenhouse Challenge Plus, see Sullivan, R. (2006), 'Greenhouse Challenge Plus: A New Departure or More of the Same?', *Environmental and Planning Law Journal*, Vol. 23, No. 1, pp. 60-73.

[23] See, for example, the comments of the Australian Industry Greenhouse Network which has argued that the priority for the Australian government should be to raise the profile of the voluntary approach to greenhouse, rather than singling out leaders for specific praise (AIGN (2005) (Note 13)).

[24] AGO (2005b) (Note 4) at 4.

[25] As a consequence, Sullivan (2006: 71) suggests: "The consequence is that organisations are likely to continue to make economically sub-optimal decisions on investments in energy efficiency or greenhouse gas abatement. This, in turn, means that the incentives for innovation will continue to be weak." (Sullivan (2006) (Note 22)).

[26] AGO (2005e), "Industry-Government Greenhouse Partnership Committee" (AGO, Canberra, 2005).

[27] See, for example, AIGN (2005) (Note 13).

particular making greenhouse and climate issues a part of management decision-making processes[14].

Despite these positive outcomes, the overall contribution of the Greenhouse Challenge to reducing greenhouse gas emissions from Australian business appears to have been relatively modest. The Greenhouse Challenge did not provide strong incentives for participating organisations to set greenhouse gas emission reduction targets beyond business as usual, and the existence of the Greenhouse Challenge was used by industry to deflect calls for the introduction of stronger policy measures such as emissions trading. It appears that the major contributions of the Greenhouse Challenge were to encourage some organisations to bring forward some energy saving or greenhouse gas emission reduction projects and to help participating organisations to identify opportunities that provided clear short-term financial benefits[15]. While many of the participants stabilised their greenhouse gas emissions over the period 1995 to 2000[16], emissions from Australian business as whole have continued to rise, with emissions from the electricity sector some 35% higher in 2004 than in 1990 and emissions from industrial processes 18% higher[17].

While Australian business has strongly supported the Greenhouse Challenge, environmental groups argued that the Greenhouse Challenge was simply a public relations campaign for activities that would have happened anyway[18]. Environmental non-governmental organisations (NGOs) expressed concern about the close relationship between government and industry in the Greenhouse Challenge, in particular the emphasis on the confidentiality of industry data and the absence of a formal role for NGOs in the Joint Consultation Committee (JCC) which oversaw the operation of the Greenhouse Challenge.

As a final comment on the Greenhouse Challenge, it is difficult to evaluate the precise contribution that the programme has made to achieving greenhouse gas emissions reductions. In a 2004 review, the National Audit Office noted that the emissions reductions claimed for the Greenhouse Challenge did not take account of what would have happened in the absence of the Greenhouse Challenge, the effect of corporate environmental management systems, or the effect of State and Territory greenhouse programmes[19]. The review also highlighted significant inconsistencies in the emissions reductions that the government had predicted for participating organisations and the actual reductions achieved[20]. Furthermore, given that participating organisations were free to define their own baselines and business as usual performance, there was clearly the potential for participating firms to overstate their expected emissions growth thereby allowing them to claim that they have achieved even greater reductions in emissions[21].

Expected Outcomes from Greenhouse Challenge Plus

The Greenhouse Challenge Plus appears to address some of the weaknesses of the Greenhouse Challenge[22]. First, the Greenhouse Challenge Plus is not a purely voluntary programme but offers clear financial incentives for certain companies to participate although, given that many of these companies are already likely to be participants, this may not result in a significant increase in membership of the programme. Secondly, the Greenhouse Challenge Plus now differentiates between participating companies. The incentives associated with Greenhouse Leaders should,

prima facie, encourage companies to go beyond – and stay beyond - minimum compliance with the requirements of the programme. It remains to be seen how many companies will actually decide to become Greenhouse Leaders, as companies may be concerned that a failure to continue to meet the requirements of Greenhouse Leaders will lead to criticism or negative press coverage[23]. Thirdly, the improved disclosure requirements (in terms of the information that companies are required to put into the public domain) should address at least some of the NGO concerns about the lack of transparency. However, it is pertinent to note that the Greenhouse Challenge Plus retains its strong emphasis on the protection of commercial information[24] and it is therefore likely that NGOs will continue to be critical of the programme in this regard.

However, many of the weaknesses of the Greenhouse Challenge remain unaddressed. Most importantly, the Greenhouse Challenge Plus does not impose specific performance targets on participating companies or provide strong incentives for companies to significantly reduce their greenhouse gas emissions beyond business as usual[25]. A further issue is that the oversight structure (the Industry-Government Partnership Committee) that has been established for the Greenhouse Challenge Plus continues to exclude key stakeholders[26]. It is therefore likely that environmental NGOs will continue to criticise the programme. Finally, the Greenhouse Challenge Plus may be less acceptable to Australian industry, which has expressed concern at the move away from the strictly voluntary approach that characterised the Greenhouse Challenge[27].

5. Critical analysis of carbon trading arrangements

5.1. Context

The basic theory of carbon trading is simple. An agreement is made to cap, or limit, a pollutant (in this case carbon dioxide and other greenhouse gases) at a certain level. Permits, or credits, are then allocated to countries, firms, industries and/or other entities (even individuals) to emit a stated amount over a given time period. Those whose emissions exceed the credits they possess at the end of the period will be penalised. Permit or credit holders are then free to trade these with each other in a free market. Entities that can reduce their emissions at a low cost will do so and then sell credits to others who are unable to do so (hence 'cap and trade'). A shortage of credits will drive up the price of credits and make it more profitable for firms to engage in pollution reduction. In this way the desired reduction is met at the lowest cost possible to society. Over sequential periods the cap is progressively tightened[clxxvi]. Perhaps the most frequently cited model of a cap and trade system judged successful is that of sulphur dioxide and nitrogen oxides in the United States[clxxvii].

Carbon trading was included in the 1997 Kyoto Protocol as one of the options available to countries with mandatory emission reduction targets. The Protocol came

into force in 2005. Through the Clean Development Mechanism (CDM) those countries are allowed to 'earn' credits by investing in offset projects that cut emissions in developing countries which have no Kyoto targets. With costs of emission reduction typically much lower in developing countries than in industrialised countries, it is reasoned, industrialised countries can comply with their emission reduction targets at much lower cost by receiving credits for emissions reduced in developing countries as long as administration costs are low. The most popular location for projects generating carbon credits under the CDM in 2006 was China, which took a 63 per cent share of the market. India generated 12 per cent of credits and Africa nearly 6 per cent, up from about 2.5 per cent in 2005.

The European Union Emission Trading Scheme (EUETS) began trading in January 2005. Each participating country has a National Allocation Plan (NAP)[clxxviii] specifying emissions caps on emissions for individual power plants and factories in energy-hungry industries (e.g. iron and steel, cement, glass, paper). In aggregate these facilities and factories account at present for approximately 45% of greenhouse gas emissions by the EU. Each one gets a maximum amount of emission allowances for a given period (e.g. 2005-2007 and 2008-2012) and may trade with other facilities that have an excess or deficit of allowances. Progressively tightening caps are foreseen for each new period, forcing overall reductions in emissions. Between inception and November 2006, the EUETS traded contracts totaling about 18 billion euros (US$23.1 billion)[clxxix]. About one billion tonnes of CO2 were traded during this period, equivalent to the annual greenhouse gas emissions of Germany, Europe's largest emitter.

All the other carbon trading arrangements in operation at present are smaller than the CDM and EUETS, and in most cases they are voluntary. One example is the Chicago Climate Exchange, 'the world's first and North America's only voluntary, legally binding greenhouse gas reduction and trading system for emission sources and offset projects in North America and Brazil'[clxxx]. A mandatory scheme has been envisaged for the State of California[clxxxi], and may be an option at the inter-provincial level in Canada[clxxxii]. Many US corporations see a cap and trade system as inevitable for the US by 2012.

Some corporations have also experimented with internal carbon trading systems between business units. The best known example is probably BP, which operated an internal emissions trading system between 1999 and 2001. The company said this helped reduce operational greenhouse gas emissions by 10 percent at no net economic cost[clxxxiii] (during this time, however, the quantity of oil and gas produced and sold by BP continued to increase). Several large multinational corporations are calling for extension and development of existing carbon trading arrangements[clxxxiv], including US-CAP, which regards cap and trade as an essential element in what it says is a pressing need to reduce greenhouse gas emissions world wide[clxxxv].

Carbon trading markets have grown rapidly in recent years. According to an estimate by the World Bank, US$22bn worth of greenhouse gas emissions was traded world wide in the first nine months of 2006, compared with over $10bn in the whole of 2005. Of this, about $3bn took place within the CDM and $19bn in the EUETS[clxxxvi]. Investment banks, including Goldman Sachs, Barclays Capital and JPMorgan, have

expanded into the carbon emissions trading market, mainly through their energy and commodity trading desks. In October 2006 Morgan Stanley announced plans to invest about $3bn in carbon credits and energy projects to reduce greenhouse gas emissions under the CDM, the largest commitment to date by a financial intermediary to the carbon emissions market[clxxxvii].

Demand for Certified Emissions Reductions (CERs) under the terms of the CDM is likely to remain strong during the first period of the Kyoto Protocol. The government of Japan, for example, estimates that it will need to buy 100 million tonnes CERs under between 2006-2013 as part of its programme to meet its commitments. At the time of writing the future of the CDM beyond the end of the Kyoto commitment period is uncertain. The EU pledge of a 20% reduction in emissions by 2020 may indicate parameters for the EUETS at least until that date.

5.2. Do they work?

Both the Clean Development Mechanism and the European Union Emission Trading Scheme have been strongly criticised. But criticisms are different in each case. Critics of the CDM tend to argue that the emission reductions it claims to achieve would have been achieved anyway. In the case of the EUETS, criticisms to date have tended to focus on what are said to be excessively generous national allocation plans by EU member governments which mean that little or no real reduction has been achieved. Defenders of the CDM and EUETS argue that the schemes are in the first phase, with lessons being learned that will lead to better operation in future.

Under CDM, approved projects are required to show 'additionality'. This is a contested term with two main interpretations: 'environmental additionality', which holds that a project is additional if the emissions from the project are lower than the baseline; and 'project additionality', defined as projects that would not have happened without the CDM. Advocates of the CDM tend to agree it is not possible to establish with absolute certainty what would have happened without the CDM or in absence of a particular project. They argue, however, that a good estimate can be made using the official guidelines set by the CDM Executive Board for assessing additionality[clxxxviii].

Another criticism of the CDM is that, far from achieving emissions reductions at a lower cost, the largest projects so far have paid up to 50 times more for the emission reductions than the costs alone would warrant, with the 'excessive profits' ending up with the factories and the carbon traders[clxxxix]. According to one estimate, €4.6 billion spent under CDM on the destruction of HFC gases[cxc] would have would cost only €100 million if funded by development agencies. The UNFCCC says the loophole is now closed and that new HFC-23 facilities will no longer be eligible for CDM credits[cxci]. The international emission trading association (Ieta) has expressed support for HFC-23 emission reduction projects. It says they have been 'hugely successful', and should not be attacked on the basis of 'environmentally irrelevant considerations'[cxcii].

Some analysts say critics of the CDM are missing the point. It was not designed to be a mechanism for development, poverty alleviation or technology transfer, but simply to facilitate the greatest abatement at the lowest marginal cost. In this, they say, it has

been successful[cxciii].

The first phase of the EUETS, running from 2005 to 2007, has been criticized for offering 'no incentive' for emission cuts[cxciv]. This followed revelations in April and May 2006 that many companies were issued more allowances than they needed by national governments. As a result the price of carbon collapsed[cxcv]. However, despite the problem of over-allocation, estimate to be some 100 million tonnes of CO2 in 2005, some studies have argued that abatement under EUETS probably reduced total emissions by between 50 million tonnes and 200 million tonnes[cxcvi].

5.3. Where next?

The EUETS is widely seen as a key test case of whether cap and trade can work on large scale for greenhouse gas emissions, and potentially the cornerstone for a global trading scheme. Almost everyone, from radical anti-capitalist critic to mainstream economists, agrees the current scheme has problems. Proponents of trading argue that design flaws in the EU ETS are teething troubles which can be resolved. In January 2007, for example, the European Commission recommended tighter caps in the second phase from 2008 to 2012, changes including more predictability for investors, more auctioning of permits[cxcvii], the inclusion of more industry sectors (such as semi-conductor and refrigeration manufacturers) and widening of the scheme to the transport sector, including aviation[cxcviii].

The sheer scale of the scheme means that member states are subject to intense lobbying by economically strategic industries. In the first phase, lobbyists across Europe pushed successfully for weak caps, and argued successfully for "grandfathering" – for allocations to be based on their emissions in a reference period rather than on an overall carbon target, as under Kyoto, or on best practice in the industry. If this is repeated in subsequent phases it risks creating a perverse incentive for companies to increase emissions, because it will give them a higher allocation in the next phase[cxcix].

Some participant companies in the EUETS have had to buy a few permits in the market match actual emissions at the margin in the first phase, but in most cases the bulk of permits have been free. This 'free give away' of emission permits has been challenged[cc]. Some studies indicate that companies increase prices to consumers as if they were paying for all their permits. UBS Investment Research calculates that the first phase of the EU ETS has added around 1 penny (US 2 cents) to each kilowatt hour of electricity. Consultants to Britain's Department of Trade and Industry said that British electricity generators were expected to make windfall profits of around £800m in 2005. Consultants for the commission looking at the inclusion of aviation in the ETS recently estimated that airlines could make up to €4bn in windfall profits, depending on the emissions permit price[cci]. Even if such issues are resolved, emissions trading schemes such as the ETS can only play a meaningful role in carbon budgeting if actual curbs in total emissions are agreed and enforced.

At the time of writing, pressure in the United States for greenhouse gas emissions trading is increasing sharply[ccii], with speculation that a scheme will come into existence no later than early in the next presidential term, commencing January 2009. At least six bills to address climate change are expected to come before the Senate in

2007, with all but one of them including a mandatory 'cap and trade' system to limit emissions. Three bills which limit emissions are expected before the House of Representatives. Most initiatives see the US as part of an international emissions trading scheme similar to Kyoto but with a revised timetable for emission reductions.

6. Prescriptions for an accelerated shift to carbon neutral growth

There is no magic bullet for accelerating the transition to a low carbon economy[cciii], but directions for action in rich industrial countries such as Australia, Canada, Japan and the member states of the European Union are clear.

One, governments must be direct about the risks of *not* substantially reducing emissions, and make clear that they are serious about short, medium and long-term targets for emission reductions.

Two, all emissions associated with the life cycle of goods and services of *all* economic activities, including aviation, shipping and military spending, should be counted accurately and completely, and communicated with utmost transparency to all sectors and groups of world society.

Three, comprehensive investigation, identification and elimination of subsidies to industries, services and other economic activities – including aviation, automobile use and agriculture – that contribute to greenhouse gas emissions.

Four, an old principle – the polluter pays – should be applied consistently and fairly with regard to greenhouse gas emissions as much as to any other kind of pollution which contributes to severe and irreversible damage of the environment and ecosystems on which humanity depends. Emission permits under cap and trade systems should no longer be allocated by governments without cost, but should be auctioned or otherwise sold for fees which can be applied for abatement and other purposes central the over-riding goal of reducing emissions[cciv].

Five, rich country governments should prioritize regulations and incentives that actually reduce emissions. In particular, they should address market failure in demand management and energy efficiency[ccv], [ccvi]. Carbon abatement can be achieved at substantial negative cost (i.e. profit) in rich industrialized countries through building insulation, fuel efficiency in commercial vehicles, lighting systems, air-conditioning, water heating, and electronic equipment standby losses[ccvii]. Governments should focus particular attention on these challenges, working with consumers and industry to develop innovative ways to address these market failures, and where necessary finance up front capital investment, with aggressive targets in particular for efficient energy use in the commercial and domestic housing sectors. In some cases this may include mechanisms that deliver a share of the rewards from energy savings to the energy providers and/or manufacturers.

Six, it has been shown that voluntary approaches from the commercial sector do not delivering actual emission reductions. Firm targets for efficiency increases through regulation must not be allowed to be unpicked by vested interests, as has been the case for automobile efficiency in the European Union. Auctions for emission permits

under cap and trade schemes can be recycled at least in part to those companies that make the greatest progress in reducing their emission profiles.

Seven, Australia, Canada, the European Union and Japan should reaffirm their commitment to tackling climate change in a context of sustainable development and justice for the peoples of all nations[ccviii]. This requires that they commit to carbon budgets for themselves and also support for developing nations for the most cost effective and equitable methods to tackle the challenge those countries will face in bringing their own emissions under control while meeting human and economic development goals for their people.

END

Notes

[i] *The Varieties of Scientific Experience*. Carl Sagan (New York, 2006) quoted in *Creating an Alien Planet* by John Cairns http://www.johncairns.net/Commentaries/Creating_an_Alien_Planet-2.pdf

[ii] opening remarks by Sir John Houghton CBE FRS to *From Anthropocentrism to Ecocentrism: Making the Shift* EcoRes Forum E-Conference, 14-30 April 2007

[iii] *Joint science academies' statement: Global response to climate change*, 7 Jun 2005 http://www.royalsoc.ac.uk/document.asp?id=3222. The statement is endorsed by the national academies of science of Brazil, Canada, China, Italy, India, Japan, France, Germany, Russia, United Kingdom and the United States.

[iv] Neither the UNFCCC nor the Intergovernmental Panel on Climate Change define 'dangerous climate change'. It is argued that the judgement is or should not be solely a scientific one, but also involves ethical and political factors. Some impacts may only occur at a regional level – e.g. across one continent or a large part of one continent. Stephen H. Schneider and Janica Lane of Stanford University write: "in essence, the threshold of what is dangerous depends not only on the probabilities of factors like climate sensitivity and adaptive capacity, but on value judgements as to what is acceptable given any specific level of warming or damage – and who suffers the damage or pays the adaptation cost". (*An Overview of 'Dangerous' Climate Change* in Avoiding Dangerous Climate Change, Schellnhuber et al, 2006)

[v] European Union 1939th Council meeting, Luxembourg, 25 June 1996: 'the Council believes that global average temperatures should not exceed 2 degrees above pre-industrial level'. Updated at *Limiting Global Climate Change to 2 degrees Celsius* 10 Jan 2007 http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/16&format=HTML&aged=0&language=EN&guiLanguage=en

[vi] There may be significant changes to the earth climate system for an average temperature rise of less than 2 C. For example, the loss of coral reefs which play an important role in supporting fisheries for up to several hundred million people and other valuable ecosystem services.

[vii] Anthropogenic gases that cause climate change include carbon dioxide, methane nitrous oxide and fluorinated gases. For further details see *The Main Greenhouse Gases*, Pew Center on Global Climate Change http://www.pewclimate.org/global-warming-basics/facts_and_figures/climate_science_basics/main_ghgs.cfm

[viii] Among key factors regarding the risks of climate change to be taken into account are *regional* distribution of impacts and the *timeframe* over which they take place. Some parts of the world may be much more severely affected than others. And some impacts of the current atmospheric concentration of greenhouse gases (let alone mind its future concentration) may not be apparent for several decades, or even more.

[ix] The IPCC was established in 1988 by two UN organisations, the World Meteorological Organisation and the United Nations Environment Programme, to evaluate the risks of climate change.

[x] Fourth Assessment Report Summary for Policy Makers: "AR4", 2 February 2007 http://www.ipcc.ch/SPM2feb07.pdf

[xi] AR4 page 12

[xii] That is, a doubling with respect to the average pre-industrial atmospheric concentration of carbon dioxide. The concentration before the industrial revolution that began in the late 18th century was approx 270 parts per million by volume ('270ppmv')

[xiii] IPPC definitions are: 'more likely than not' as a more than 50% probability of an event taking place; 'likely' as more than 66%; 'very likely' as more than 90%; and 'extremely likely' as more than 95%

[xiv] Twice pre-industrial concentration would be approximately 550ppm. The current level is more than 380ppm (CO_2 only). Atmospheric concentrations are rising by approximately 2ppm per year.

[xv] "Climate-carbon cycle coupling is expected to add carbon dioxide to the atmosphere as the climate system warms, but the magnitude of this feedback is uncertain. This increases the uncertainty in the trajectory of carbon dioxide emissions required to achieve a particular stabilisation level of atmospheric carbon dioxide concentration."

[xvi] Some commentators have alleged manipulation and censorship of AR4. See *Climate Report 'was watered down'*, New Scientist 8 March 2007, and *Political Corruption of the IPCC Report?* http://www.meridian.org.uk/Resources/Global%20Dynamics/IPCC/index.htm

[xvii] *What does a 2 C target Mean for Greenhouse Gas Concentrations?* Malte Meinhausen in Schellnhuber et al, 2006

[xviii] CO_2e equivalent, or CO_2e, is the internationally accepted measure that encapsulates all greenhouse gases that contribute to global warming. Some greenhouse gases have a greater 'global warming

potential', or GWP, than carbon dioxide. (GWP is a measure of how much a given mass of greenhouse gas contributes to global warming). Methane, for example, has a GWP 21 times as great as CO_2e. At present other greenhouse gases contribute approximately an additional 15% of global warming potential.

[xix] Emission pathways leading to a 550ppm CO2e stabilisation are unlikely to meet the 2C target. In order to achieve such a target with a probability of more than 85% (60%) global greenhouse gas concentrations need to be stabilised at 400 (450) ppmv CO2e or lower.
"This requires global emissions peak at around 2015 in order to avoid global reduction rates exceeding more than 2.5%/yr, followed by substantial overall reductions by as much as 40-45% (15-25%) in 2050 compared to 1990 levels excluding land use emissions. The reduction requirement become as high as 50-55% (30-40%) below 1990 levels for 2050 in 2050 for all greenhouse gas emissions including land use CO2." –*Multi-Gas Emission Pathways for Meeting the EU2 C Target*, Michael den Elzen and Malte Meinhausen in Schellnhuber et al, Defra 2006

[xx] For example, "to stabilize at 450ppmvCO2e without overshooting, global emissions would need to peak in the next ten years and then fall at more than 5% per year, reaching 70% below current levels by 2050. This is likely to be unachievable with current and foreseeable technologies." (Stern Review on the economics of climate change, Chapter 8, page 218 http://www.hm-treasury.gov.uk/media/9A2/DD/ch_8_challenge_of_stabilisation.pdf)

[xxi] See, for example, *Risks Associated with Stabilisation Scenarios and Uncertainty in Regional and Global Climate Change Impacts*, Stainforth et al in Shellnhuber, 2006)

[xxii] For example, the World Energy Technology Outlook reference case envisages world energy use to by 2.2 as great in 2050 as it is today (albeit for a economy four times as large) resulting in an emission profile corresponds to a concentration of CO2 in the atmosphere between 900 to 1000 ppmv by 2050.

[xxiii] For example, "to stabilize at 450ppmvCO2e without overshooting, global emissions would need to peak in the next ten years and then fall at more than 5% per year, reaching 70% below current levels by 2050. This is likely to be unachievable with current and foreseeable technologies." (Stern Review on the economics of climate change, Chapter 8, page 218 http://www.hm-treasury.gov.uk/media/9A2/DD/ch_8_challenge_of_stabilisation.pdf)

[xxiv] "If the official verdict on climate change seems bad enough, the real story looks far worse". Leading climate scientists identified a series of potential positive feedbacks and "tipping points" not included in most current models of the Earth's climate system that could accelerate global warming of sea-level rise. These include the collapse of the Greenland ice sheet, rapid melting in Antarctica, a shut down of the Gulf stream in the Atlantic, and the release of carbon dioxide and methane from soil, the ocean bed and melting permafrost.

[xxv] August 2006

[xxvi] 18 February 07

[xxvii] "The climate-carbon cycle is expected to add carbon dioxide to the atmosphere as the climate system warms, but the magnitude of this feedback is uncertain. This increases the uncertainty in the trajectory of carbon dioxide emissions required to achieve a particular stabilisation level of atmospheric carbon dioxide concentration." AR4, page 17

[xxviii] give references for all three, e.g. Yadvinder Malhi (?), X, Carl Wunsch (?)

[xxix] This includes, for example, the US government. On 5 February 2007, Sharon Hayes of the White House office of Science and Technology Policy said: "This report is a comprehensive and accurate reflection of the current state of climate change science".

[xxx] AR4 page 17

[xxxi] AR4 appears to be referring to 450ppm CO_2 *only*, not 450ppm CO_2e

[xxxii] Gigatonne of carbon is commonly abbreviated as GtC.

[xxxiii] It should be noted that AR4 appears to be referring to the concentration of CO_2 only, whereas what 'matters' is the combined effect of all greenhouse gases, expressed as CO_2 equivalent (CO_2e). To stabilise the concentration of all greenhouse gases at 450ppm CO_2e means stabilising CO_2 alone at a significantly lower level. The additional forcing factor of other greenhouse gases apart from CO_2 depends on the timespan under consideration, as different greenhouse gases have different atmospheric residence times. Other factors, such as the negative radiative forcing of aerosols should also be taken into account.

[xxxiv] http://www.grida.no/climate/ipcc/emission/spm-4a.htm

[xxxv] In 2004 emissions from fossil fuel use were in the region of 7.4 GtC. See US Energy Information Administration http://www.eia.doe.gov/emeu/iea/carbon.html (report released May- June 2006). [note figures are given in Gigatonnes of carbon dioxide. To convert to carbon divide by 3.67]. For a

breakdown of estimated carbon dioxide emissions by country see also http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions

[xxxvi] 57% of total global anthropogenic emissions of greenhouse gases in 2000 came from burning fossil fuels in power, transport, buildings and industry; agriculture and land use changes (particularly deforestation) produced 41% of emissions (source WRI 2006 cited in Stern Review p 170). Total global emissions in 2000 from both fossil fuel combustion and non energy emissions (waste, agriculture and land use change) were 42GtCO2e or 11.44GtCe

[xxxvii] approx. 25.47% of global emissions from fossil fuels in 2004

[xxxviii] approx 24.12% of global emissions from fossil fuels in 2004. Other high income industrial nations such as Norway, New Zealand, Singapore and Switzerland are not included in this figure.

[xxxix] *CO2 is Not the Only Gas*, Keith P. Shine and William T. Sturges, Science, 30 March 2007, Vol 315

[xl] This is not always true. Take the following example. The Netherlands emits 80 million tonnes of carbon per year from all activities. Indonesia emits 2,000 million tonnes from forest fires and land use change alone – i.e. not including household and commercial consumption of fossil fuels. (Source: Marcel Silvius, senior programme manager for Wetlands International, quoted in Smoking Out the World's Lungs, BBC 10 Feb 2007. http://news.bbc.co.uk/go/pr/fr/-/2/hi/asia-pacific/6354079.stm).That is, current Indonesian emissions per capita are nearly twice those of the Dutch, even if its emissions from fossil fuel combustion are not counted and those of the Netherlands are.

[xli] See Brouns and Ott etc.

[xlii] http://unfccc.int/2860.php signed in 1992 by 154 nations, now signed by 189

[xliii] The principle of "common but differentiated responsibilities" recognises that: 1) the largest share of historical and current global emissions originated in developed countries; 2) per capita emissions in developing countries are still relatively low; and 3) the share of global emissions originating in developing countries will grow to meet their social and development needs.

[xliv] The Annex 1 countries are Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, European Union, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States of America.

[xlv] Those countries that are required to make cuts include Canada, Japan and those of the European Union

[xlvi] Under the Kyoto Protocol to the UNFCCC, Annex I countries agree to reduce their emissions to target levels below their 1990 emissions levels. If they cannot do so, they must buy emission credits or invest in conservation. The United States and Australia have signed the UNFCCC but not the Kyoto Protocol, and thus are not under a legal obligation to meet 'Kyoto targets'.

[xlvii] Note: need to spell out in final paper what the budget means for world as a whole. This should include a graph here to illustrate emissions trajectories for OECD and non OECD to 2100

[xlviii] *Multi-gas Emission Pathways for Meeting the EU 2 C Climate Target.* Michel den Elzen and Malte Meinhausen in Schellnhuber et al, 2006

[xlix] Taking the lower bound of IPCC SRES Scenario B1 as maximum global emissions. See http://www.grida.no/climate/ipcc/emission/spm-3.htm

[l] Using conversion factor of 3.67

[li] Figures for 1990 and 2004 from the UNHDR Australia country study

[lii] Figures for 1990 and 2004 from the UNHDR Canada country study

[liii] European Environment Agency

[liv] Figures for 1990 and 2004 from the UNHDR Japan country study

[lv] On basis that population in 1990 was 18m, in 2004 was 20m and in 2050 will be 40m

[lvi] On basis that population in 1990 was 28m, in 2004 was 30m and in 2050 will be 60m

[lvii] With EU 25 (i.e not including Romania and Bulgaria) population at 464 million, Japan 130m, Canada 32m, Australia 20m, and total world population at 6.5bn

[lviii] Assuming populations of EU and Japan increase by 5%, while those of Canada and Australia double, and total world population is 9.4bn (US Census bureau estimate at http://www.census.gov/ipc/www/worldpop.html)

[lix] citation needed

[lx] 1990 is the base line for the Kyoto Protocol, and is also used more generally used as a baseline for future measurements. For example, California is using 1990 as a metric for future reduction targets

[lxi] See http://tromoya.grida.no/db/maps/collection/climate9/flash/emissiongraphs.swf for animation of difference between projected emissions and Kyoto targets all Annex 1 countries

[lxii] Of which 0.6% was to have come from actual domestic emission reductions, 3.8% from forestry and 1.6% from purchase of CERs under the Kyoto mechanism. See Japan country study for more details
[lxiii] UNHDR Japan Country Study
[lxiv] *Japan Proposes Halving Emissions by 2050*. AP 24 May 2007
[lxv] Greenhouse gas emissions and removals – European Environment Agency, February 2007. For full break down of all countries and all sectors by year see tables at http://dataservice.eea.europa.eu/dataservice/viewdata/viewpvt.asp
[lxvi] That is, members before 2004: Austria, Belgium, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom
[lxvii] *Making Sweden an oil free society*, Commission on Oil Independence, 21 June 2006 http://www.sweden.gov.se/content/1/c6/06/70/96/7f04f437.pdf
[lxviii] The other three were: the impact of oil prices on growth and employment, the link between oil, peace and security throughout the world, and the great potential of Sweden's renewable energy resources.
[lxix] *Towards an Oil Free Economy in Ireland: Lessons from the Swedish Commission for Oil Independence Report* by Joseph Curtin, IEA Briefing Paper, 10 August 06, http://www.iiea.com/images/managed/events_attachments/Towards%20an%20Oil%20Free%20Economy%20in%20Ireland-1.pdf
[lxx] *Making Sweden an oil free society*, Commission on Oil Independence, 21 June 2006 http://www.sweden.gov.se/content/1/c6/06/70/96/7f04f437.pdf
[lxxi] See also Background paper by Gregor Czisch including section with overview on Germany electricity production
[lxxii] Further reading *Feed-in Tariffs – Accelerating the Development of Renewable Energy* by Miguel Mendonca, Earthscan 2007
[lxxiii] EEA Annual European Community greenhouse gas inventory June 2006
[lxxiv] The Guardian 31 Jan 07
[lxxv] *We call on the EU to abandon targets for biofuel use in Europe*. An open letter signed by more than 200 organisations, 31 Jan 2007, http://www.biofuelwatch.org.uk/2007Jan31-openletterbiofuels.pdf
[lxxvi] 061026 T&E Euro auto emissions
[lxxvii] Liquid fuels derived from coal would almost certainly mean larger emissions. Biofuels are not suitable for use in jet engines. Hydrogen, generated by whatever means, presents significant problems of storage. See *Green sky thinking: eight ways to a cleaner flying future*, New Scientist, 22 Feb 2007 http://www.newscientist.com/article/mg19325921.600;jsessionid=HJILNFIIMHEB
[lxxviii] Aviation and the global atmosphere, IPCC 1999 http://www.grida.no/climate/ipcc/aviation/003.htm
[lxxix] http://www.rcep.org.uk/news/02-04.htm
[lxxx] This figure is used in a UK Conservative Party document on taxing aircraft emissions, March 2007
[lxxxi] *Predict and Decide – Aviation, climate change and UK Policy*, Environmental Change Unit, University of Oxford 2006
[lxxxii] *CO2 output from shipping twice as much as airlines*, The Guardian, 3 March 2007
[lxxxiii] by Simon Donner, Princeton University
[lxxxiv] Canada's Energy Outlook: The Reference Case 2006, Analysis and Modeling Division, Natural Resources Canada. Available at: http://www.nrcan.gc.ca
[lxxxv] *Oil Sands Update*, Government of Alberta, June 2006. Available at: http://www.energy.gov.ab.ca/docs/oilsands/
[lxxxvi] ibid
[lxxxvii] Canada's Energy Outlook: The Reference Case 2006, Analysis and Modeling Division, Natural Resources Canada. Available at: http://www.nrcan.gc.ca
[lxxxviii] *Oil Sands Update*, Government of Alberta, June 2006. Available at: http://www.energy.gov.ab.ca/docs/oilsands/
[lxxxix] ibid
[xc] *Suncor Energy 12th annual progress report on climate change (2006)*. Suncor Energy Inc. Available at http://www.suncor.com
[xci] Pembina Institute. *The Climate Implications of Canada's Oil Sands Development*. Available at http://www.pembina.org
[xcii] Ibid; Canada's Energy Outlook: The Reference Case 2006, Analysis and Modeling Division, Natural Resources Canada. Available at: http://www.nrcan.gc.ca

[xciii] *Climate Change: The upstream oil and natural gas industry's contribution to Canada's debate on climate change and the Kyoto Protocol*, Canadian Association of Petroleum producers, February 2002. Available at http://www.capp.ca
[xciv] *Report of the Commissioner of the Environment and Sustainable Development to the House of Commons*, Office of the Auditor General, Government of Canada, September 2006. Available at: http://www.oag-bvg.gc.ca/domino/other.nsf/html/06en03_e.html
[xcv]National Roundtable of the Environment and the Economy, 2006. *Advice on a Long-term Strategy on Energy and Climate Change*, Available at http://www.nrtee-trnee.ca.
[xcvi] McCulloch, M., Raynolds, M. and Wong, R, 2006. *Carbon Netural 2020: A Leadership Opportunity in the Oil Sands: Oil Sands Paper #2*. Pembina Institute. Available at http://www.pembina.org
[xcvii] Ibid.
[xcviii] by Caridad Canales Davila and Alberto Carrillo Pineda, Oxford University Centre for the Environment
[xcix] Organisation for Economic Co-operation and Development. (2004). Environmental Performance Reviews: Spain. Paris: France.
[c] Nieto. J. and Santamaría J. (2006). Evolución de los gases de efecto invernadero en España 1990-2005. Confederación Sindical de Comisiones Obreras, Departamento de Medio Ambiente: España.
[ci] *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies,* Science, 13 August 2004, Vol 305
[cii] In January 2007 US President George W Bush announced an ambitious agenda to increase the supply of alternative fuels by setting a mandatory fuels standard to require 35 billion gallons of renewable and alterative fuels in 2017.
[ciii] Directive on the Promotion of the use of biofuels and other renewable fuels for transport, 2003/30/EC, set a target of 5.75% by 2010. COM(2006) 845 raised the biofuel target to 10% by 2020
[civ] Lester R. Brown *The Earth Is Shrinking: Advancing Deserts and Rising Seas Squeezing Civilization*, Earth Policy Institute 15 November 2006, http://www.earth-policy.org/Updates/2006/Update61.htm
[cv] "Surging demand for irrigation to produce food and biofuels is likely to aggravate scarcities of water but the world's supply is not running out, according to a report the International Water Management Institute", Reuters, 20 August 2006.
Biofuels adding to water shortages
http://www.iwmi.cgiar.org/Press/coverage/pdf/Biofuels%20adding%20to%20water%20shortages.pdf
Biofuels: implications for agricultural water use
http://www.iwmi.cgiar.org/EWMA/files/papers/Biofuels%20-%20Charlotte.pdf
[cvi] The marginal cost of a tonne of CO2(e) abated by production of biodiesel in Europe is much higher than bifuel from sugarcane on the cost curve for greenhouse gas reduction described by Per-Anders Enkvist, Tomas Nauclér, and Jerker Rosander, McKinsey Quarterly, January 2007, http://www.mckinseyquarterly.com/article_page.aspx?ar=1911&L2=3&L3=41
[cvii] Michael B McElroy, *The Ethanol Illusion*, Harvard Magazine, November-December 2006 http://www.harvardmagazine.com/print/110634.html
[cviii] Biofuels less sustainable than realised, Wetlands International, 8 December 2006 http://www.wetlands.org/news.aspx?ID=804eddfb-4492-4749-85a9-5db67c2f1bb8
[cix] See, for example, *International Trade in biofuels: Good for development, and good for environment?* IIED, January 2007. http://www.iied.org/pubs/pdf/full/11068IIED.pdf Key messages: "1) The realisation of environmental and social benefits of biofuels is not straightforward. The trade-offs need to become clearer to all players. 2) International trade will play a key role in determining the final outcomes. However, distortions in agricultural and energy trade regimes, the myriad of standards and the lack of a clear biofuel classification in the multilateral trade regime, suggest that biofuels might not deliver sustainable development gains for all trading partners. 3) Industrialised countries need to analyse the global impacts of their domestic policies affecting biofuel production and trade…4) Developing countries need to seize the opportunities and appreciate the costs of the biofuels market, identifying those that are most suitable for the achievement of their sustainable development goals. 5) The scale of biofuels production matters for achieving economies of scale. But large-scale models run the risk of squeezing out small-scale producers and the associated sustainable development benefits. 6) Standards for the biofuels sector are proliferating. Mapping their implications for sustainable development and trade could help to evolve a more equitable regime".
[cx] Gregory Stephanopoulos, *Challenges in Engineering Microbes for Biofuels Production*, Science (Special Section on Sustainability and Energy), Vol 315, 9 February 2007

[cxi] Some sub national jurisdictions in the US, Australia and elsewhere have set themselves Kyoto type targets, and/or more similar or more ambitious ones. Ref – [New South Wales, California]. Japan has not yet set a post Kyoto target (see Japan country study).
[cxii] "The EU target needs to be seen in the context of the need for international action of industrial nations on climate change. When such a commitment exists, the EU will need to do more. **The aim should therefore be to increase the target to a 30% reduction by 2020 and 60-80% by 2050** [emphasis added]. The concern is not only about climate change, it is also about Europe's security of energy supply, economy and the wellbeing of its citizens. Even without climate change, there is every reason to take the steps proposed by the European Commission"- An Energy Policy for Europe
[cxiii] by Rory Sullivan, Insight Investment
[cxiv] See, for example, Knapp, R. (2004), 'Australian Aluminium Council [AAC] Submission to the Senate ECITA Committee Inquiry into the Kyoto Protocol Ratification Bill 2003 [No. 2]. 30 January 2004' (AAC, Canberra); Plastics and Chemicals Industries Association (PACIA) (2004), 'Submission to Senate Standing Committee on Environment, Communications, Information Technology and the Arts in Relation to its Inquiry into the Kyoto Protocol Ratification Bill 2003 (No 2). January 2004' (PACIA, Melbourne). It is important to note that industry views are not homogenous with the CEOs of a number of major Australian businesses – BP Australasia, Insurance Australia, Origin Energy, Swiss Re, Visy Industries, Westpac – calling for early action on climate change (Australian Business Roundtable on Climate Change (2006), 'Joint CEO Statement'. http://www.businessroundtable.com.au/html//jointceo.html).
[cxv] For an extremely critical assessment of the influence of corporate lobbying on Australian climate change policy, see Hamilton, C. (2006), 'The Dirty Politics of Climate Change'. Speech to the Climate Change and Business Conference, Adelaide, 20 February 2006.
[cxvi] Australia's activities are not confined to meeting its obligations (e.g. the requirement to prepare national greenhouse gas inventories) under the UNFCCC but also include activities such as providing assistance to developing countries in support of the UNFCCC. For example, since 1996-1997, Australia has contributed over $279 million to bilateral and regional development assistance for activities that contribute to sustainable development while reducing net greenhouse gas emissions, or that help developing countries adapt to climate change, with a particular focus on forestry, land management and renewable energy. In addition, the Australian Government has provided funding for capacity development in developing countries, for helping vulnerable Pacific small island developing states to monitor and adapt to climate change, and for research and development in areas such as climate prediction.
[cxvii] Howard, J., Downer, A., MacFarlane, I. and Campbell, I. (2005), 'Press Release: Australia Joins New Asia-Pacific Partnership on Clean Development and Climate. 28 July 2005' (Department of the Environment and Heritage, Canberra). For information on the activities of the Asia–Pacific Partnership on Clean Development and Climate, see http://www.asiapacificpartnership.org (last visited 27 December 2006).
[cxviii] (AGO) (2005a) at 125-126.
[cxix] AGO (1998a), *The National Greenhouse Strategy* (AGO, Canberra). The concept of no regrets (i.e. those measures that are financially worthwhile in the absence of any concerns regarding global warming) has been criticised because it is seen as having the effect of effectively excluding climate change as a factor in decision-making processes (see, further, Hamilton, C. (1996), 'Thinking About the Future: Equity and Sustainability', in Department of the Environment, Sport and Territories (1996), *Equity and the Environment* (Department of the Environment, Sport and Territories, Canberra, Australia), pp. 16-21).
[cxx] Howard, J. (1997), 'Safeguarding the Future: Australia's Response to Climate Change. Statement by The Prime Minister of Australia, The Hon. John Howard MP, 20 November 1997'
[cxxi] AGO (2006c)
[cxxii] The Strategy – which consolidates previous climate change initiatives such as initiatives - is articulated through measures contained in the 2004–05 Federal Budget (see Department of the Environment and Heritage (2004), *Budget 2004*-2005 (Department of the Environment and Heritage, Canberra) and the 2004 Energy White Paper (Commonwealth of Australia (2004), *Securing Australia's Energy Future* (Commonwealth of Australia, Canberra)).
[cxxiii] AGO (2006c). For a breakdown of the expected emissions abatement from the different programmes and policy measures, see Australian Greenhouse Office (AGO) (2005a) at 60-66
[cxxiv] For a more detailed description see: Australian Greenhouse Office (AGO) (2005a) at 3-6, 36-66. See also the Australian Greenhouse Office website: http://www.greenhouse.gov.au/ (last visited 27 December 2006).

[cxxv] http://www.greenhouse.gav.au/ggap/index.html (last viewed 27 December 2006).
[cxxvi] Parliament of the Commonwealth of Australia (2000), *The Heat is On: Australia's Greenhouse Future. Report of the Senate Environment, Communications, Information Technology and the Arts Committee* (Commonwealth of Australia, Canberra); Australian Greenhouse Office (2004a), *National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Indicators 1990 to 2002* (AGO, Canberra).
[cxxvii] The measure will be implemented through the *Renewable Energy (Electricity) Act 2000* and the *Renewable Energy (Electricity) (Charge) Act 2000*, supported by the *Renewable Energy (Electricity) Regulations 2000.*
[cxxviii] Commonwealth of Australia (2004); Allen Consulting Group (2003), *Sustainable Energy Jobs Report. Prepared for the Sustainable Energy Development Authority* (Allen Consulting Group, Sydney).
[cxxix] See, for example, State of Victoria, Department of Sustainability and Environment (2005), 'Victorian Greenhouse Strategy Action Plan Update' (State of Victoria, Melbourne); New South Wales Greenhouse Office (2005), *NSW Greenhouse Plan* (NSW Greenhouse Office, Sydney); Government of Western Australia (2004), *Greenhouse Strategy* (Government of Western Australia, Perth). The Victorian government's strategy is representative of the strategies that have been adopted. The strategy sets out four broad objectives, namely promoting actions that deliver reductions in net greenhouse gas emissions, positioning Victoria to prosper in a low carbon economy, developing understanding of the adaptive responses required to deal with the impacts of climate change and increasing community awareness about the actions needed to reduce emissions. For industry and commerce, the measures adopted include: requiring licensed facilities to implement best practice with respect to energy efficiency and greenhouse gas emissions and to conduct energy audits for existing licensed premises and implement actions that have a financial payback of up to three years; supporting the development and application of sustainable energy technologies and practices in manufacturing; supporting the uptake of greenhouse gas abatement technologies; supporting cleaner energy technologies such as improving the combustion efficiency of lignite and supporting the development of geo-sequestration; improving public reporting of greenhouse gas emissions for large emitters; improving energy management in large commercial buildings (State of Victoria, Department of Sustainability and Environment (2005)). One of the key elements of the New South Wales responses is its Greenhouse Gas Abatement Scheme (GGAS), which requires electricity retailers and large electricity users choosing to participate to meet mandatory annual targets for greenhouse emissions, or pay a financial penalty. The Scheme requires electricity retailers to achieve 5% reduction in per capita emissions by 2007 compared to 1990 emission levels, and then maintain those levels until 2012 (see, further, http://www.greenhousegas.nsw.gov.au; Independent Pricing and Regulatory Tribunal (IPART) (2006), *Compliance and Operation of the NSW Greenhouse Gas Abatement Scheme During 2005* (IPART, Sydney)).
[cxxx] State of Victoria, Department of Sustainability and Environment (2005).
[cxxxi] New South Wales Greenhouse Office (2005)
[cxxxii] See, for example, State of Victoria, Department of Infrastructure and Department of Sustainability and Environment (2004), *The Greenhouse Challenge for Energy* (State of Victoria, Melbourne) at 2 which states: "Market mechanisms, such as emissions trading, offer an efficient and effective means of providing incentives for emissions abatement. Victoria supports the development and implementation of a national emissions trading scheme led by the federal government, in close consultation with all States and Territories… A Victorian-only emissions trading scheme is not proposed as this would be an inefficient route to greenhouse gas abatement and would disadvantage Victoria's economy in the absence of equivalent action by other States and Territories."
[cxxxiii] See further http://www.emissionstrading.net.au/home
[cxxxiv] National Emissions Trading Taskforce (2006), 'Possible Design for a National Greenhouse gas Emissions Trading Scheme. August 2006' (National Emissions Trading Taskforce).
[cxxxv] by Simon Donner, Princeton University
[cxxxvi] Canada, 2002. *A Discussion Paper on Canada's Contribution to Addressing Climate Change.*
[cxxxvii] Government of Canada, 2002. *Climate Change Plan for Canada*. Available at http://www.tc.gc.ca/programs/environment/commitments/climateChangePlan.htm
[cxxxviii] Government of Canada, 2005. *Moving Forward on Climate Change: A Plan for Honouring our Kyoto Commitment*. Available at http://www.ic.gc.ca/cmb
[cxxxix] Stoett, P, 2006. Canada, Kyoto and the Conservatives: Thinking / Moving Ahead. In *Climate Change Politics in North America* (ed. H. Selin and S. VanDeveer), Woodrow Wilson Center for International Scholars' Canada Institute, Washington DC. Available at http://www.wilsoncenter.org

[cxl] Government of Canada, 2005. *Memorandum of Understanding between the Government of Canada and the Canadian Automotive Industry respecting Automobile Greenhouse Gas Emissions*, April 5, 2005.
[cxli] Report of the Commissioner of the Environment and Sustainable Development to the House of Commons, The Commissioner's Perspective, Office of the Auditor General, September 2006, 66 pages. Available at http://www.oag-bvg.gc.ca/domino/other.nsf/html/06en03_e.html
[cxli] Dion, S. Canada's Climate change dilemma and how to solve it. *Policy Options*, October 2006, p 25-31.
[cxlii] Government of Canada, 2006. *Bill C-30, The Clean Air Act*. Available at: http://www.parl.gc.ca/common/bills_ls.asp?lang=E&ls=c30&source=library_prb&Parl=39&Ses=1
[cxliii] "Harper agrees to send Clean Air Act to committee", *CBC News*. December 1, 2006. Available at: http://www.cbc.ca/canada/story/2006/11/01/layton-green.html
[cxliv] "PM charts a greener course", *The Globe and Mail*, January 5, 2007. Available at: http://www.theglobeandmail.com/servlet/story/LAC.20070105.SHUFFLE05/TPStory/Front
[cxlv] Building a sustainable future for Canada: Stéphane Dion's Energy and Climate Change Plan, 53 p. Available at http://www.stephanedion.ca.
[cxlvi] by Peter D Petersen (see 2007 UNHDR Japan Country Study)
[cxlvii] See tables 1 and 2 in the 2007 UNHDR country study for details
[cxlviii] The calculation is made on the assumption that if forestry trends as of 2005 continue until 2010, Japan will not be able to meet its forest sink target of 3.8%. The CO_2 reduction potential is measured against a BAU scenario from 2005-2010.
[cxlix] This is to meet the target for reduction target of 1.6% through the Kyoto mechanism. (Source: Progress report on the Kyoto Protocol Target Achievement Plan, Ministry of the Environment, July 7th , 2006 (Japanese only)).
[cl] Presidency Conclusions, 8/9 March 2007, http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/93135.pdf See especially paragraphs 30 to 32:
'30. The European Council reaffirms that absolute emission reduction commitments are the backbone of a global carbon market. Developed countries should continue to take the lead by committing to collectively reducing their emissions of greenhouse gases in the order of 30% by 2020 compared to 1990. They should do so also with a view to collectively reducing their emissions by 60% to 80% by 2050 compared to 1990.
31. In this context, the European Council endorses an EU objective of a 30% reduction in greenhouse gas emissions by 2020 compared to 1990 as its contribution to a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and economically more advanced developing countries to contributing adequately according to their responsibilities
and respective capabilities. It invites these countries to come forward with proposals for their contributions to the post-2012 agreement.
32. The European Council emphasises that the EU is committed to transforming Europe into a highly energy-efficient and low greenhouse-gas-emitting economy and decides that, until a global and comprehensive post-2012 agreement is concluded, and without prejudice to its position in international negotiations, the EU makes a firm independent commitment to achieve at least a 20% reduction of greenhouse gas emissions by 2020 compared to 1990.'
[cli] *BP chairman warns EU on emissions fight*, The Financial Times, 18 March 2007 http://www.ft.com/cms/s/f81146a0-d57f-11db-a5c6-000b5df10621.html
[clii] *Coal comeback pushes up UK emissions*, The Guardian, 29 March 2007
[cliii] *UK Greenhouse gas emissions: Are we on target?* Environment Institute, University College London, March 2007 http://www.ucl.ac.uk/environment-institute/pdfs/UCLEI-report.pdf
[cliv] *UK plans to cut CO2 doomed to fail – scientists*, The Guardian, 5 March 2007
[clv] Kevin Anderson and Alice Bows, Tyndall Briefing Note 17, March 2007 http://www.tyndall.ac.uk/publications/briefing_notes/bn17.pdf
[clvi] In 1998 the *New York Times* published an America Petroleum Institute (API) memo outlining a strategy aiming to make 'recognition of uncertainty ... part of the 'conventional wisdom.'" The memo has been compared to a late 1960s memo by tobacco company Brown and Williamson which stated: "Doubt is our product since it is the best means of competing with the 'body of fact' that exists in the mind of the general public. It is also the means of establishing a controversy".
[clvii] See, for example *Smoke, Mirrors & Hot Air*: *How ExxonMobil Uses Big Tobacco's Tactics to Manufacture Uncertainty on Climate Science*, Union of Concerned Scientists, January 2007

http://www.ucsusa.org/assets/documents/global_warming/exxon_report.pdf

[clviii] WBCSD members include General Motors, DuPont, 3M, Deutsche Bank, Coca-Cola, Sony, Caterpillar Inc., BP and Royal Dutch Schell. It also works with a network of more than national and regional business councils

[clix] *Policy Directions to 2050 – A business contribution to the dialogues on co-operative action*, March 2007. See 'An international framework built on national approaches' (page 6). The report does not suggest a specific target for atmospheric concentrations of greenhouse gases, but introduces two scenarios for trajectories to 900ppm and 550pm by 2050 (page 3). http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MjM0OTQ

[clx] http://www.combatclimatechange.org/about.html Members include ABB, Alcan, Alstom, Areva, Bayer, BP, Centrica, CEZ Group, Deutsche Bahn AG, Deutsche Post World Net, Duke Energy, Endesa, EnBW, Enel, E.ON, Eskom, Fortum, GE, Lufthansa, Norske Skog, NRG Energy, Nuon, Otto Group, PG&E Corporation, PNM Resources, Reuters, Siemens, Suez, RAO UES of Russia, Wallenius Lines and Vattenfall.

[clxi] In its guiding principles, 3C notes that it may be necessary to stabilise at less than 550ppmv: 'According to present knowledge, the goal should be to stabilise the carbon dioxide equivalent concentration at a level below 550 parts per million (volume) in order to stabilise the temperature increase at an acceptable level. **There are signals indicating that the acceptable concentration level may have to be even lower in the future.** [Emphasis added] The long-term goal must be based on sound scientific and economic analyses. An assessment process should be designed to monitor the progress'. http://www.combatclimatechange.org/guiding_principles.html#6

[clxii] Full list of participants at http://www.earth.columbia.edu/grocc/participants.html

[clxiii] *'The Path to Climate Sustainability': A Joint Statement by the Global Roundtable on Climate Change* 20 February 2007, http://www.earth.columbia.edu/grocc/grocc4_statement.html The Roundtable describes its over-arching objectives over the period 2005 to 2009 as: to explore the potential for developing an improved global consensus on core scientific, technological, economic and policy issues related to climate change; to explore technological and policy options for mitigating climate change while meeting global energy needs; to champion demonstration projects that test and scale sustainable energy technologies and other activities and policies that address climate change; to provide a unique forum for discussion, analysis and exchange of ideas among businesses from all economic sectors and all parts of the world, international institutions, non-governmental organizations, and leading academic experts; and to help catalyze new initiatives and interactions among Roundtable participants that address climate change mitigation and adaptation.

[clxiv] Among notable examples are BP's internal emissions trading scheme, which is said to have reduced emissions from operations by some 10%, and GE's 'Ecomagination'.

[clxv] Dupont, for example, says it will reduce its greenhouse gas emissions by 65% with respect to 1990 levels by 2010. See The Climate Group case study: http://theclimategroup.org/reducing_emissions/case_study/dupont/

[clxvi] *Climate Change: Adapt or Bust* http://www.lloyds.com/NR/rdonlyres/38782611-5ED3-4FDC-85A4-5DEAA88A2DA0/0/FINAL360climatechangereport.pdf

[clxvii] http://www.cdproject.net/

[clxviii] Reporting by some companies has been challenged: 'In February 2007, a report by the NGO Christian Aid found that Greenhouse gas emissions running into hundreds of millions of tonnes had not been disclosed by Britain's biggest businesses, masking the full extent of the UK's contribution to global warming. Only 16 of Britain's top 100 listed companies are meeting the government's most elementary reporting guidelines on greenhouse gas emissions. As a result, almost 200m tonnes of CO2 is estimated to be missing from the annual reports of FTSE 100 companies. The figure is more than the entire annual emissions of Pakistan and Greece combined.' http://www.christianaid.org.uk/indepth/0702_climate/index.htm

[clxix] As of 1st February 2007

[clxx] http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm In February 2007 the Stern team published a response to critics of their economic analysis *Value judgements, welfare weights and discounting* at http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

[clxxi] Two sectors tipped for growth are 1) providers of energy efficiency and 2) renewable energy. For example, the Dutch company Phillips launched a 'campaign' in Washington DC in March 2007 to phase out all inefficient lighting in North America by 2016. Replacing the approximately 4 billion incandescent light bulbs in the United States with energy efficient ones would cut the US's annual

electricity bill by $18bn, and cut CO2 emissions by 158Mt, says the company. Also in March 2007 the European Lamp Companies Federation (ELC) today announced the 'first-ever joint industry commitment to support a government shift to more efficient lighting products for the home' The ELC estimates that there are 3.6 billion inefficient lamps in use in Europe. Assuming that an average of 50% of energy consumed could be saved by changing to energy efficient home lighting, Europe could save approximately 23 megatonnes of CO2, which is equal to the output of 27 power plants (@ 2TWh) or electricity cost saving of 7 billion Euros (http://www.elcfed.org/index.php?mode=0). Revenue from clean-energy companies worldwide increased nearly 39% to a collective $55.4 billion last year, according to a research report released this month by Clean Edge. By 2016, the collective revenue of such companies could reach $226.5 billion, the report said.
http://www.investmentnews.com/apps/pbcs.dll/article?AID=/20070326/FREE/70323010

[clxxii] An analysis by the UK NGO Christian Aid published in February 2007 found that major corporations in the London FTSE 100 were under-reporting their emissions some 191.42MtCO2 – nearly 35% of total UK emissions (CO2 only) *Coming Clean: Revealing the UK's true carbon footprint* http://www.christianaid.org.uk/indepth/0702_climate/missingcarbon.pdf

[clxxiii] by Peter David Pedersen, e-squareinc.com

[clxxiv] *Follow-up on the Voluntary Action Plan*, METI, Dec. 21, 2006 (Japanese only)

[clxxv] by Rory Sullivan, Insight Investment

[clxxvi] Chapters 14 and 15 of the Stern Review have extensive discussions on emission trading schemes and carbon taxes

[clxxvii] See, for example, *Economics of Pollution Trading for SO2 and NOx*
http://ideas.repec.org/p/rff/dpaper/dp-05-05.html

[clxxviii] http://ec.europa.eu/environment/climat/emission_plans.htm

[clxxix] Point Carbon, 21 November 2006

[clxxx] The Chicago Climate Exchange (CCX) says that 'To date, more than 120 CCX Members range from corporations like Ford and Motorola, to state and municipalities such as Oakland and Chicago, to educational institutions such as Tufts University and University of Minnesota, to farmers and the Iowa Farm Bureau. CCX has an aggregate baseline of 226 million metric tonnes of CO_2 equivalent, which is equal to the United Kingdom's annual allocation under the EU ETS. This would make CCX one of the largest 'countries' in the EU CO_2 market, or 4% of U.S. annual GHG emissions'.
http://www.chicagoclimatex.com/

[clxxxi] *PUC to set cap on greenhouse gas emissions*, 16 Feb 2006
http://www.ieta.org/ieta/www/pages/getfile.php?docID=1485

[clxxxii] Canada emissions trade seen worth C$12 bln, 14 March 2007
http://www.ieta.org/ieta/www/pages/index.php?IdSitePage=1355

[clxxxiii] On BP see Pew Climate
http://www.pewclimate.org/companies_leading_the_way_belc/company_profiles/bp_amoco/trading.cfm For a business oriented overview see Climatebiz backgrounder: emissions trading
http://www.climatebiz.com/sections/backgrounder_detail.cfm?UseKeyword=Emissions%20Trading

[clxxxiv] For example, The Evolution of Global Carbon Trading Announced at World Economic Forum, 29 Jan 2007
http://www.climatebiz.com/sections/news_detail.cfm?NewsID=34507&Section=Emissions%20Trading&ImageName=hdr%5Fsect%5Femiss%5Ftrade%2Egif&Section=Emissions%20Trading See also section on corporate initiatives in this paper

[clxxxv] A Call for Action - Consensus Principles and Recommendations from the US Climate Action Partnership http://www.us-cap.org/ClimateReport.pdf

[clxxxvi] Financial Times, 16 November 2006

[clxxxvii] *Morgan Stanley makes $3bn green pledge*, Financial Times, 26 October 2006

[clxxxviii] Tool for the demonstration and assessment of additionality. UNFCCC
http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf

[clxxxix] *Is the global carbon market working?* Michael Wara, Nature, February 8, 2007
http://cesp.stanford.edu/news/967/ (see also *Measuring the Clean Development Mechanism's Performance and Potential* by Michael Wara, Stanford PESD paper no.56 http://iis-db.stanford.edu/pubs/21211/Wara_CDM.pdf. *Billions lost in Kyoto carbon trade loophole*, Financial Times, 8 Feb 2007 http://www.ft.com/cms/s/c07a48b4-b6d9-11db-8bc2-0000779e2340.html

[cxc] CHF3, also known as R-23 or HFC-23, is a potent greenhouse gas, with a global warming potential 11,700 times as great as carbon dioxide and an atmospheric lifetime of 260 years

[cxci] *Kyoto Protocol 'loophole' has cost $6 billion*, New Scientist, 9 Feb 2007
http://environment.newscientist.com/article/dn11155-kyoto-protocol-loophole-has-cost-6-billion.html

[cxcii] *Emission traders defend HFC-23 projects*, 3 March 2007 http://www.ieta.org/ieta/www/pages/index.php?IdSitePage=1344

[cxciii] Personal communication, officer with a company trading CERs under the CDM. The company had no involvement in the HFC-23 projects in China or elsewhere.

[cxciv] 'The EU emissions trading scheme has not encouraged installations to reduce their emissions, according to one of the companies covered by the scheme. "Let's be realistic and honest, the market was long in the first phase, so the EUETS has given no extra incentives for greenhouse gas reductions or changes to the fuel mix," Philip Luyten, environment manager at Total Petrochemicals'. ENDS 1 Feb 2007

[cxcv] In an analysis of the Phase I National Allocation Plans (*National Allocation Plans 2005-07 Do they deliver?* http://www.climnet.org/EUenergy/ET/NAPsReport_Summary0306.pdf), the NGO Climate Action Network called the caps a 'major disappointment'. CAN argued that only the UK and Germany of the 25 EU states asked the participating industry sectors to reduce emissions compared to historic levels and found that in the 15 old EU member states as a whole allocations were 4.3% higher than the base year. In May 2006, when several countries revealed registries indicating that their industries had been allocated more allowances than they could use, trading prices crashed from about €30/ton to €10/ton, and after a slight recovery declined to €4 in January 2007 and below €1 in February 2007

[cxcvi] Massachusetts Institute of Technology and the Eni Enrico Mattei Foundation. 28 November 2006

[cxcvii] "The UK's long-term aim is to move away from free allocation and towards full auctioning as the most efficient allocation methodology. This will ensure the cost of carbon is fully taken into account and provide greater incentives for firms to develop cleaner technology than allocating allowances for free" – Ian Pearson, UK Minister of State for Climate Change and Environment, quoted in ENDS report, 1 Feb 2007.

[cxcviii] See, for example *Trading Up: Reforming the European Union's Emissions Trading Scheme*, IPPR, December 2006

[cxcix] This analysis thanks to Matthew Lockwood, *A Rough Guide to Carbon Trading*, Prospect Magazine, January 2007

[cc] and not only by NGOs "The UK's long-term aim is to move away from free allocation and towards full auctioning as the most efficient allocation methodology. This will ensure the cost of carbon is fully taken into account and provide greater incentives for firms to develop cleaner technology than allocating allowances for free" – Ian Pearson, UK Minister of State for Climate Change and Environment, quoted in ENDS report, 1 Feb 2007.

[cci] IPPR op cit http://www.ippr.org.uk/pressreleases/?id=2488

[ccii] Climate Policy Frenzy continues in US Congress, Point Carbon, 28 March 2007, http://www.pointcarbon.com/getfile.php/fileelement_105855/Carbon_Market_North_America_28_March_2007.pdf

[cciii] For a thorough analysis of the challenges see Stern Review, especially parts III (The economics of stabilisation) to VI (International collective action)

[cciv] The limitations of existing cap and trade sytems embodied in the Kyoto Protocol and the EUETS are not be limited to free allocation of permits. Alternatives, with potentially lower transaction costs and less scope for abuse, should be further explored. These alternatives include more 'straight' carbon taxes and alternative trading arrangements such as that outlined in 'Kyoto 2' http://www.kyoto2.org under which those seeking to extract and sell carbon based fuels would have to take part in auctions.

[ccv] "Even if the energy efficiency of the world economy – gross world product per unit energy – were to continue to increase at the long term historical rate of about 1% per year, the realisation of middle or the road population and economic projections would entail quadrupling of energy use in this century. In a world where today one third of primary energy comes from oil and 80% comes from oil, coal and natural gas combined (virtually all the carbon dioxide from the combustion of which continues to go straight into the atmosphere), that middle of the road energy trajectory cannot be managed simply by expanding what we are already doing. Such a path is not merely unsustainable; it is a prescription for disaster" John Holdren, *Science* , 9 Feb 2007

[ccvi] EREC/Greenpeace scenario – proven RE and efficient decentralised cogeneration – excludes CCS and nuclear energy – worldwide final energy demand reduced by 47%

[ccvii] *A cost curve for greenhouse gas reduction* by Per-Anders Enkvist, Tomas Nauclér, and Jerker Rosander McKinsey Quarterly 2007 No 1

[ccviii] A renewed agenda 20 years after Brundtland has been suggested: 'A 20-year international effort to put the planet on a path to sustainable development has been woefully inadequate and will need a radical rethink if it is to achieve its aims' according to a report by the International Institute for

Environment and Development (IIED). The new approach would require 1) Traditional, local and non-Western approaches to play a major role in a new, globally constructed and globally shared drive towards genuine sustainable development: 2) A shift from the inviolability of economic growth to the inviolability of human well-being and environmental limits; and 3) Governments to account for the economic and social benefits that natural resources provide and the costs of mismanaging these environmental assets. http://www.iied.org/mediaroom/docs/new_era.pdf