CLIMATE CHANGE MITIGATION MAY WELL END THE PLATINUM AGE

A SUBMISSION TO THE GARNAUT REVIEW

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Abstract

This Submission sets out a more rational basis for setting targets for greenhouse gas emission reductions than that of all current proposals, and shows that such targets do not need to be as severe as commonly supposed. It then queries the apparently already firm decision of the Garnaut Review to adopt the Howard-Shergold preference for an emissions trading scheme (ETS) as the method of choice for implementing emission reduction targets, and shows that a system of payments of bounties to those who reduce emissions is preferable. The ETS will have deleterious effects on the Australian economy, especially if initial allocations of credits are auctioned, as already proposed by Garnaut, and on its own will have zero net impact on emissions. Worse than that, the ETS will encourage dumping of captured carbon either in the ocean, or near built-up areas, with unimaginable consequences.

Garnaut's choice of the Prisoners' Dilemma as his model of how to deal with the problem of securing international agreement on reducing emissions of the so-called dangerous greenhouse gases appears to be fallacious, and the outcome of the Bali process in December implies as much. R.H. Coase's work on the problem of social cost is far more relevant. This Submission then outlines the arithmetic and other errors (if not *prima facie* scientific fraud) in the claims by the IPCC and by Canadell et al. (2007a and 2007b) that the efficiency of the natural earthly sinks of carbon dioxide is declining when in fact it is increasing. Finally, the Submission notes the absence of econometric analysis showing the claimed adverse economic effect of greenhouse gases in both the Stern Review and the IPCC's AR4, and outlines some evidence showing the beneficial economic impact of the major "greenhouse gases", namely water and carbon dioxide, which the Garnaut Review will perversely seek to reduce.

Ross Garnaut's answer to the question he posed in his recent S.T. Lee lecture was that "climate change and poorly designed responses to it could bring the Platinum Age to an end". This Submission will suggest it is Garnaut's apparent decision that his

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Review will propose an emissions trading scheme (ETS) that may well, if adopted both in Australia and globally, wreak far more havoc on the world economy in general, and on Australia in particular, than even the most pessimistic of the many IPCC scenarios of the impact of climate change by 2100, without achieving *any* net reduction in emissions of greenhouse gases.

Garnaut's decision that emission trading, rather than carbon taxation, is the way to go seems strange when it is not required by his Review's terms of reference, and shows surprising conformity with the Howard government's adoption of the ETS recommended by the Shergold Report (2007). Moreover most economists, notably in America, favour taxes – but see also Humphreys (2007) and the cogent criticisms of the Shergold scheme by Robson (2007).[2]

This Submission puts forward a third option, which consists of paying bounties to emitters that succeed in reducing their emissions. That has many advantages: it is direct, addresses the problem at source, and avoids all the complications of an ETS, including both deadweight transaction costs and zero impact on emissions.

I begin with some comments on the incomplete analysis of climate change by the IPCC, with the nearly total disregard, and even denial, by many of its thousands of Nobel Peace Prize-winners of the extraordinary rapid rate of growth of the photosynthetic uptakes of carbon dioxide emissions by the oceanic and terrestrial biospheres. The *Stern Review*, so often cited by Garnaut, does not analyse this phenomenon in depth, yet it is crucial to understanding of the carbon cycle. Moreover, while there are no direct measures of the extent of net photosynthesis, the reasonably well measured levels of both emissions of carbon dioxide from burning of fossil fuels and of the level of the atmospheric concentration of carbon dioxide, yield the actual level of global uptakes from this accounting identity: $\mathbf{\Delta A = E - U}$**,** where $\mathbf{\Delta A}$ is the change in the atmospheric concentration of carbon dioxide from year to year, **E** is annual emissions, and **U** is total Uptakes derived as a residual from $\mathbf{U = E - \Delta A}$ (see also Curtin 2007, Annex II below).

This identity necessarily shows that since the rate of growth of carbon dioxide emissions has been over 2 per cent a year since the 1980s, but has been rising to over 3 per cent p.a. since 2003, it *must* be accompanied by an at least similar growth of uptakes, since the reported increase in the atmospheric concentration of carbon has been increasing at only 0.4 per cent p.a. since 1958 (but rising to about 0.5 per cent a year since 2003). My Fig.1 shows that despite the increasingly rapid growth in fossil fuel emissions, the airborne fraction (AF) of all carbon dioxide emissions from burning of fossil fuels that is retained in the atmospheric CO2 concentration, as measured at Mauna Loa since 1958, has actually been falling. *This implies a more than proportionate increase in the photosynthetic uptakes.*

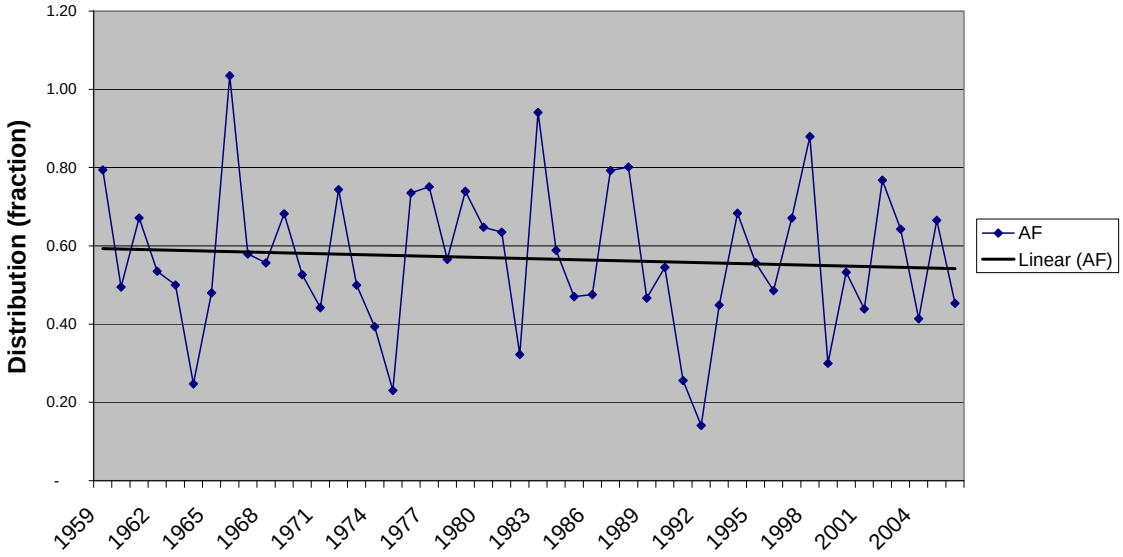
It also follows from the identity that if there is any under-recording of total global emissions of carbon dioxide, including respiration from human beings and all other living animals and plants, as well as decaying vegetation and animal matter – and there are no extant global measurements of these sources of carbon dioxide – this *necessarily* implies *larger* total Uptakes. For example, given the IPCC data that total

[2] E.g. Nordhaus and Boyer 2000.

fossil fuel emissions averaged 7.2 GtC (billion tonnes of carbon) per annum in 2000-2005, and that the average uptake in the atmosphere was 4.1 GtC, then the average net uptakes were 3.1 GtC (WGI 2007:Table 7.1). But with the atmospheric level as a given at 4.1, if the total emissions (including all anthropogenic – fuel emissions and our own breathing - plus all other emissions from respiration by other living and decaying matter) were say 12 GtC, then *necessarily* the photosynthetic uptakes would by the identity have to be 7.9 GtC.

It follows that there is no need to reduce anthropogenic emissions of carbon dioxide below the evident level of net photosynthetic uptakes (Hansen and Sato, 2004). However, recent work by Canadell *et al.* of both IPCC (WG I) and CSIRO (in two papers, 2007) provides some very misleading "data" (most is simply wrong arithmetically as well as being in conflict with their own contributions to the IPCC's WGI, 2007) which claims that the airborne fraction of carbon dioxide emissions is increasing, contrary to the trend line shown below in my Fig.1 (see their Fig.2 in Canadell *et al.* 2007a, also shown here as my Fig.2).

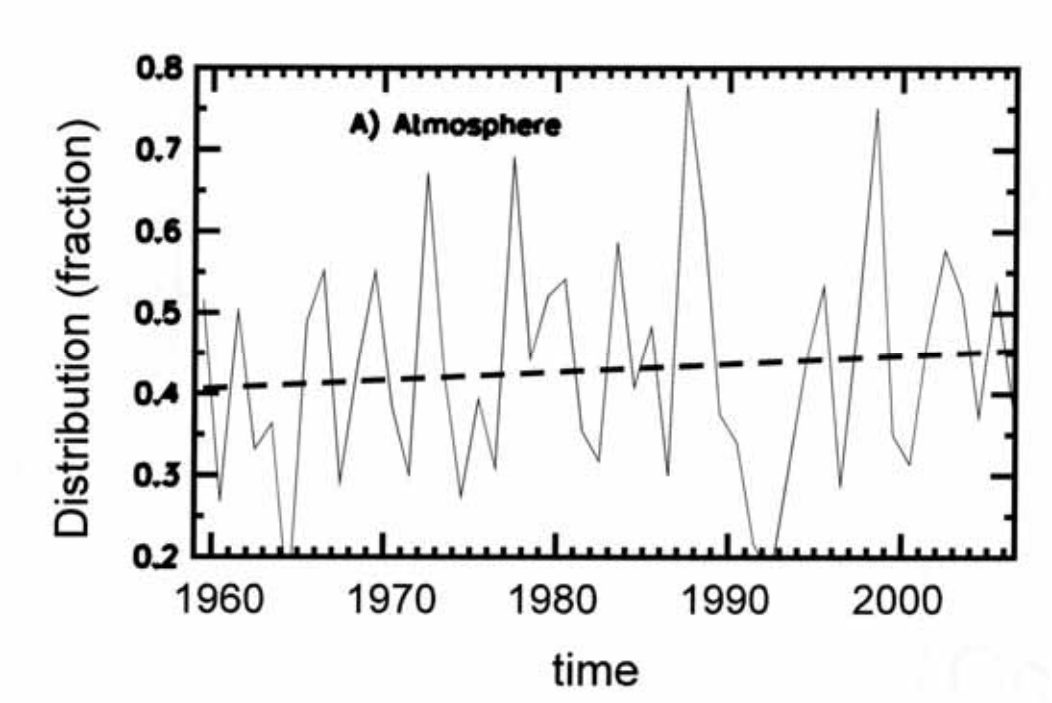
Fig 1 The Airborne Fraction
Proportion of total CO_2 emissions retained in the atmosphere



Source: Marland et al., CDIAC 2007.

Allegedly, in Fig.2 "the observed (sic) trend in Airborne Fraction was +25% per year (p=.89) from 1959 to 2006, implying a decline in the efficiency of natural sinks of 10%" Canadell *et al.*, 2007b. My Fig.1 above used the same sources as Canadell *et al.* 2007, but without any massaging. As also shown in my spreadsheet (Table 4 below) the log linear growth rate of the Airborne Fraction derived from the same CDIAC data source used by Canadell *et al.* is **minus 0.1088 per cent p.a.,** not their "+25% per year".

Fig.2 The Canadell "Time Dynamics of the Airborne Fraction"



Source: Canadell *et al.*, PNAS, 2007

The method of calculation of the "growth rates" that underpin the claim by Canadell *et al.* (October 2007, Table 1) uses this formula, unknown, to most finance and statistics textbooks, to derive their so-called "proportional trend, $\%y^{-1}$", $(X)^{-1}(dx/dt)$ "where angle brackets denote an average over the indicated period" (2007, Table 1). Curiously, Canadell *et al.* (PNAS, 2007) do not mention Hansen and Sato (also PNAS, 2004), whose discussion of the "Airborne Fraction" shown in their Fig.5A finds that despite large annual fluctuations, it "has been remarkably constant at c.60% of emissions" since 1945 (2004:16112).[3]

It results in their claim that the rate of growth of the atmospheric concentration of carbon dioxide was "1.89% p.a." between 1959 and 2006. At that rate, starting from 314.67 ppm in 1958, the level now would be 773 ppm, beyond the wildest dreams of the IPCC and nearly all who were at Bali, rather than the actual boring 382 ppm (which has grown at just under 0.4% p.a. since 1958). Thus their figure for the growth rate of the atmospheric uptake from 1959 to 2006, **at 1.89 per cent p.a.,** is more than **4 times** faster than the recorded rate of growth of atmospheric carbon dioxide at Mauna Loa.

[3] This does not reflect well on the peer review processes of the National Academy of Science, so quick to publish a paper in 2007 that refutes a key finding in its own 2004 paper by the main progenitor of the IPCC's climate science without even mentioning it.

This is reminiscent of the Bre-X gold scam of 1994-1997 when John Felderhof (discoverer of the Ok Tedi copper and gold deposit) instigated false claims that the gold reserves at Busang in Indonesia amounted to 71 million ounces (Danielson and White, 1998). Canadell *et al.* in their Press Release of 22 October 2007 claimed **"Carbon sink slowdown contributing to rapid growth in atmospheric CO_2",** and asserted their rights to a share of Al Gore's Nobel Prize. No doubt Canadell *et al.* do not enjoy the stock options that Felderhof was able to cash in, but they have made successful careers with CSIRO, IPCC and elsewhere. Exaggerating atmospheric carbon dioxide and minimizing the level and growth of uptakes by the oceans and the biosphere is little different from overstating gold reserves when both lead on to fortune and/or research funding by the Australian Government (Canadell *et al.* were largely funded by that government's Australian Greenhouse Office and the CSIRO).[4]

Correct analysis of the data on terrestrial and oceanic photosynthetic uptakes has crucial importance for determination of both the ultimate emissions reduction target – whether to 20 or 95 per cent of emissions in 2000 by 2050 – and the minimum level of the initial emissions caps to be imposed in an ETS. Only Hansen and Sato (2004) of all those associated with the IPCC process have ever suggested that there is no reason to reduce the level of emissions of carbon dioxide *below* the rate of uptake, if the aim is to *stabilize* the atmospheric level of greenhouse gases at around 450 ppm for CO_2 : "Stabilization of atmospheric composition requires CO_2 emissions to be reduced to *match* the CO_2 absorbed by the ocean and biosphere" (2004:16114, my emphasis) For example, if the Bali Action Plan had accepted the long term rate of total terrestrial and oceanic uptake (from 1959-2006) as being 57 per cent of annual emissions of carbon dioxide (Canadell *et al.,* 2007a, Table 1), there is no reason to seek to reduce emissions by more than *43 per cent of the future* ***year-by-year*** *level of emissions.* That is why the target of the Rudd government for reduction by *60 per cent of the 2000 level* by 2050 is ill conceived, especially as it implies even larger percentage reductions from current levels, see final column of Table 1 below.

Thus there appears to be no scientific basis for the Rudd target for 2050, even less for the 95 per cent of the 1990 level target (for developed countries) of the IPCC's WG3 (2007:776) and the Bali Action Plan. Global emission reductions to the level where they are balanced by total *annual* terrestrial and oceanic uptakes (currently at least 5 GtC p.a.) will be *sufficient* to stabilise the atmospheric concentration of carbon dioxide at its level when such a programme of emission cuts takes effect – and they will be easier to sell to China than the extreme reductions insisted on by the IPCC.[5]

There is therefore no need for the Garnaut Review to adopt the hugely exaggerated targets for reductions of emissions by Australia and the rest of the world benchmarked against a *fixed* datum like the level in 1990 or 2000, when global reductions do not need to bring emissions below the ongoing *annual* level of oceanic and terrestrial uptakes. That means, using simply the raw data in Canadell *et al.,* that *total* emissions need only be reduced by 45 per cent of the 2000-2006 average level of 9.1 GtC p.a. to

[4] For a full discussion, see Annex I below. In absolute terms, total uptakes accounted for an average of 5 GtC p.a. between 2000 and 2006, while total emissions averaged 9.1 GtC p.a., according to Canadell *et al.,* 2007a: Table 1.

[5] Freeman Dyson, Professor of Physics at Princeton, shows that it makes more sense to increase terrestrial uptakes of carbon dioxide than to seek to reduce the life-giving force of the growth in the atmospheric concentration (2007).

bring them into line with the current combined average annual uptake of 5.0 GtC p.a., and not by the IPCC's Bali targets of up to 95 per cent of the average 1990 level of 8 GtC (to just 0.46 GtC)[6].

The Prisoners' Dilemma versus R.H. Coase

Much of the Garnaut lecture was taken up with discussion of the Prisoners' Dilemma.[7] That pictures two prisoners in separate cells being offered inducements to incriminate each other without being aware of what either's response might be. Clearly none of the main international players in the climate change debate is in any sense a prisoner of say the UN's Secretary General. All the players' previous positions were already well known, and so what emerged in Bali in December 2007 failed to bridge the gap and fell well short of the outcome at Kyoto in 1997, when most developed countries agreed to emission reduction targets from which developing countries were exempted.

Pace Garnaut, when his lecture refers to the problem of the Commons and the associated free riders, that problem also has nothing to with the prisoners' dilemma – and long predates it in the literature. But while his treatment of the atmosphere as being in effect a Commons is formally correct, it is also a potential minefield. The Commons in England ended with completion of the Enclosure Movement by about 1800, which established individual property rights over almost all agricultural land, and Garnaut seems to imply that may well be what is needed for atmospheric control, when he suggests that each country should be allocated its appropriate share of atmospheric gases with an agreed schedule of reductions for completion by some target date. Garnaut added: "There is already influential talk in the United States (amongst those supporting firm mitigation policies at home) and the European Union, of trade sanctions against non-cooperating countries. This is likely to become part of the framework of enforcement of cooperative behaviour on mitigation".[8]

First, although the Commission of the EU is currently (January 2008) proposing to establish trade sanctions against non-cooperating countries, it is not clear that such "enforcement" of mitigation targets by trade sanctions would be allowable under WTO rules – and attempts to use the WTO as an enforcer of global decarbonisation could well precipitate its demise. Second, international trade sanctions did nothing to

[6] Table 1 in Canadell *et al.* (2007a and b) includes a largely fictitious estimate for emissions from "land use change" that however shows no change in 2000-2006 from the level in 1970-1999 of 1.5 GtC p.a. My Table 4 shows more plausible data from CDIAC for the period from 1959 to 2004.

[7] Garnaut appears to have followed Nicholas Stern (2007) with his equally mistaken use of the Prisoners' Dilemma.

[8] Garnaut added: "I myself worry about the risk of capture by other interests favouring protection for other reasons. Withdrawal of opportunities for trade in greenhouse gas credits and development assistance would seem to be less problematic instruments of 'punishment'". Withdrawal of opportunities to trade in greenhouse gas credits would hardly be a punishment for countries that had already decided not to engage in caps and trades! China as a net lender to the West hardly needs development assistance, so Garnaut's other "punishment" is also a toothless tiger.

deter Italy in the 1930s, and US oil sanctions played a major part in propelling Japan's attack on Pearl Harbor in 1942. Do we really want a war with China?

Wiser counsel would revert to Coase's advice on the problem of the claimed divergences between private and social cost, which far more than either the Prisoners' Dilemma or the Commons is what underlies the climate change policy challenge. It is remarkable that neither Stern nor Garnaut pays much attention to Coase, yet his examples are singularly apt, dealing as he does for example with the social costs of smoke emitted by factories and of sparks from railway steam engines. His most famous example is of the confectioner, whose long-established business (in Wigmore Street, London) included use of two sets of mortars and pestles, and a doctor, whose premises (in Wimpole Street) shared a back garden well. The doctor decided to build a consulting room at the bottom of his garden, adjoining the confectioner's kitchen. Then he found the noise of the confectioner's machinery very disturbing as he did his consultations, and sought an injunction to have the confectioner stop using his machinery. "The courts had little difficulty in granting the doctor the injunction he sought". Coase argues that other courses were open, including negotiations based on mutual agreement for compensatory payments, and requiring the doctor to build a separate wall that would have deadened the noise, and that these would have enabled both to continue their business (1990: 105).

If we characterise the confectioner as China and the doctor as the EU or a post-Bush "USA", the nuisance is carbon dioxide expected to cause adverse climate change in Europe and North America, and the courts are the UNFCCC and IPCC, then the suggestion in Ross Garnaut's Lee lecture that he supported moves in the USA to impose trade penalties on China if it does not reign in its emissions corresponds to the judge in Coase's article, who was clearly biased in favour of the equally upper middle class doctor. The better outcome is Coase's, for the EU and USA to pay China to abate its emissions. Surely the worst approach (for believers in anthropogenic global warming) would be to force China and India to join in a global ETS, whereby they earn emission credits that when sold to the USA, EU and now Australia enable the latter to emit with a gladsome heart?

Also relevant is Coase's conclusion that the "proper procedure is to compare the total social product yielded by [alternative social arrangements]. The comparison of private and social products is neither here nor there" (1990:142). Stern (2007) partly adopted Coase's method, with his claim that "if we start to take strong action now [to reduce CO_2 emissions] the annual costs of achieving stabilisation [of the atmospheric concentration] between 500 and 550 ppm CO_{2e} are around 1% of global GDP" (2007:xvi). Thus he concedes that in the first instance, until about 2100, the social product will be less with mitigation than without, but fails to consider the comparative social products with either mitigation that attempts to stave off climate change or with reliance instead on adaptation to any such change that might eventuate.

Most other criticisms of the Stern Review have concentrated on its unusual cost-benefit comparisons of the "total social product" with either unmitigated climate change or mitigation. For example, its discounting methodology had the effect of exaggerating the present value of the benefits of avoiding far distant adverse climate change (even up to 2200), thereby ensuring they exceed the present costs of mitigation, while putting adaptation to one side, so that it was not even considered in

Stern's cost-benefit analysis. More complete analysis would have compared the costs of mitigation with those of adaptation for the same benefit of avoided adverse climate change. Nicholls and Tol (2006) and Bjorn Lomborg (2004, 2007) are amongst the few to have attempted this, but their findings in favour of adaptation have been ignored – despite the obvious success of Tol's fellow Netherlanders in staving off rising sea-levels for hundreds of years simply by building higher sea walls.

One hopes therefore that the Garnaut Review will not slavishly follow the Stern model. That would mean for example addressing any threat from sea-level rise on an *in situ*, or Popperian piecemeal basis, rather than relying on global emission reduction magically to reverse overnight the alleged rising sea-levels. Surely the World Bank could help to finance the Great Wall of Bangladesh, or are the rich countries of the world poorer now than was The Netherlands when the Dutch built the Zuider Zee?[9]

It would also mean addressing the pollution of the Barrier Reef by reducing nitrogenous run-offs from Queensland's agriculture, the main cause of its decline (if any), rather than again relying on global CO_2 emission reductions, not least because the future regrowth of the reef is dependent on the oceanic photosynthesis of atmospheric carbon dioxide which created the reef in the first place. However, there is a real threat to coral reefs if the surrounding ocean becomes acidic. But there is no evidence of that happening: the Pacific Ocean remains saline and alkaline (despite some marginal freshening), whereas generally there and elsewhere shallower waters and the Atlantic and Indian oceans are becoming more saline, not less, see AR4, WG1, ch.5:387). Moreover, if the Pacific did cease to be alkaline/saline, it would be available for Brisbane's water supply and Queensland's crop irrigation without any need for desalination![10]

The Caps and Trades of the ETS

The first step in installing an Emission Trading Scheme is to fix the caps or limits on emissions of greenhouse gases, chiefly carbon dioxide. If the targets bandied about in the Bali Action Plan are enshrined in Kyoto II, then these caps have to steer all countries into an *aggregate* emission reduction of 20-40 per cent of the global emissions in 1990 by 2020. That means that if say China and India refuse to cut their emissions at all, all other countries will have to reduce theirs by more than 20-40 per

[9] If Hollywood and Al Gore are right there is a real risk of rising sea-levels engulfing New York, one imagines Mayor Michael Bloomberg (who became rich in part by astute risk assessment) would already have begun building seawalls. Tol (2005) has shown how little of the world's coastline would be affected by the level of sea-level rise predicted by the IPCC.

[10] The pH of seawater is usually 8 (+/-.3), and of pure water, 7. The IPCC (AR4, 2007, WG1:77) claims there is "increasing acidification of the surface ocean" (this implies the ocean is already acidic, when what they mean to say is that the surface ocean may be becoming less alkaline). It claims that the pH of the surface ocean has reduced by 0.1 since 1750 – interesting when both the concept of pH and its measurement are only 100 years old. The IPCC (Ibid.,529, Box 7.3) in its account of "Marine Carbon Chemistry and Ocean Acidification" offers no observational evidence at all. For example: "This ocean acidification is leading to a decrease in the saturation state of $CaCO_3$ in the ocean…[but]…no conclusive quantification of the $CaCO_3$ feedback is possible at present". Usually science proceeds with hypothesis plus confirmation or not by observation. The authors of the IPCC's WG1 ch 7, including Canadell *et al.*, consider themselves above such mundane requirements.

cent, if the overall reduction is to be attained. But let us suppose that all countries – or at least all major emitters - do agree on the Bali target, they must reduce their joint annual emissions by 56 per cent of their actual 2006 level (since that is far more pertinent than the 1990 level), that is, by about 5 per cent a year of the likely 2007 level.[11] Thus the worldwide cap has to be at that annual level of reduction from the 2007 level.

Under the "trade" bit of "cap and trade", this means that all major emitting agents (Group A, e.g. power stations, aluminium smelters, cement plants, pulp and paper mills and the like) will, if they fail to reduce their emissions by 5 per cent p.a., have to find other emitters (Group B) who have reduced their emissions by that same *absolute* quantum. Ineluctably, the resulting trades do no more than preserve the *status quo ante* of the major emitters, namely their aggregate 2007 level, with the reductions by Group B exactly offsetting the amounts by which the majors failed to reduce their emissions. So in this case, the cap on total emissions fixed at 5 per cent below the 2007 level produces only a 2.5 per cent reduction in aggregate annual emissions. *Clearly the "trade" part of "cap and trade"* ***subverts*** *the "cap", which is therefore unattainable.* However it is arguable that the trades do result in those failing to reduce their emissions underwriting at least some of the costs of emission reduction incurred by those who do succeed in that enterprise.

That may be why Coase suggested that the implicit carbon tax of an ETS, with its caps (limits on emissions), should preferably be replaced by a bounty to those reducing their emissions by the prescribed amount (1988:143). This would avoid the significant transaction costs of the ETS, and would be administratively the simplest solution of all. The Government would need only to offer to reimburse coal fired power generators and firms like Alumina and Alcoa whatever it had cost them to reduce their emissions by the desired amount. This could easily and should be funded from the Commonwealth budget, mainly by use of debt instruments.

Given that the benefit of avoided climate change will accrue almost exclusively to future generations, it is right that they should bear most of the fiscal burden of servicing that debt. With the Commonwealth budget in surplus, and with no net public debt, use of new debt to finance the Coasean bounties is eminently justifiable and would have minimal adverse effects on the economy, unlike an ETS, which will immediately raise the headline rate of inflation. Moreover, financing the work undertaken to reduce their emissions by the generators and aluminium producers, who account for around 70 per cent of total carbon dioxide emissions in Australia, is just as valid an "infrastructure project" as providing them with railways, roads, and power distribution lines.

This is far preferable to the ETS approach proposed by Garnaut where the idea is that the guilty (those who emit more than their prescribed cap) should compensate the virtuous (those who emit less than their cap) by buying credits from the latter

[11] According to CDIAC, total global anthropogenic emissions from fossil fuel burning amounted to 6.2 GtC in 1990. Disregarding other emissions (e.g. from land use change), the Bali Action Plan aims at emissions by 2020 of 60 per cent of that level, or 3.72 GtC p.a. That level of emissions is just over 44 per cent of recorded emissions in 2006, so the actual reduction required by the Bali Action Plan is of the order of 56 per cent of the actual emissions of 8.44 GtC in 2006 (i.e. (3.72/8.44)*100).

sufficient to cover their transgression. Coase's objection here would be, how can we be sure that the social product *ex ante* is not larger than that *ex post*? His many examples based on historic court cases in both England and the USA provide instances of perverse outcomes much like those that may well result from an ETS.

Not only that, there is a real probability that an ETS is as much a zero sum game as most outcomes of the Prisoners' Dilemma. For example, let us suppose that Garnaut's ETS is initially aimed solely at the CO_2 emission factors of the main suppliers of energy (rather than at the users). Coal used in public electricity generation has a CO_2 emission factor of up to 100.9 $GgCO_2/PJ$. To achieve the Rudd government's declared aim of having 20 per cent of energy from renewable sources by 2020, the coal-fired generators will have to reduce their emission factor to 80 $GgCO_2/PJ$. Perhaps they can do this by Carbon Capture and Storage (CCS), with all the uninsurable risks for public health of having CO_2 buried underground at 1 million ppm, or by diversifying into windmills[12].

Both options will be costly. They will be able to avoid such investments by buying ETS credits from the producers of petroleum fuels, whose CO_2 emission factor is already only 60.2 $GgCO_2/PJ$ (for LPG). Let us say the refiners are able to meet the Rudd 20 per cent renewable energy target by refining biofuels. Unfortunately, having done so, they will only generate 12 $GgCO_2/PJ$ of ETS credits. That means the coal-fired generators will not be able to buy the 20 $GgCO_2/PJ$ they need to meet the Rudd/Garnaut target from the refiners. However they will gratefully at least buy the 12, so we then have a situation where the LPG producers sell credits from their reduction of 12 $GgCO_2/PJ$, and the coal-fired generators buy them, for zero net emission reductions from this trade. What is the point, other than the fees for the middlemen (brokers and banks) who facilitate the transaction? Meantime the generators will have to find somebody else to sell them the balance of 8 $GgCO_2/PJ$ that they desperately need to meet their Cap under the ETS. Who? When they do find a seller of their needed credits, again there is zero net emission reduction. *Every* ETS trade as such yields only a zero emission reduction. This means that since Kyoto II will presumably require across the board reductions in carbon intensity from both users and consumers of energy, as proposed by the IPCC's AR4, *the caps for all will have to be set well below the target reduction*, for only then will trading be consistent with the targets.

Why anyone believes that ETS on its own will promote NET emission reductions is an interesting sociological issue, but it is much akin to the sixteenth century belief that witchcraft was responsible for the Little Ice Age that was the main cause of poor harvests across Europe. Certainly the Shergold Report exhibits every indication of such beliefs. It also failed to appreciate that there could well be a mismatch between the *ex ante* demand and *ex post* supply of ETS credits. For example, suppose again that the coal-fired power industry proposes to reduce its emissions by 12 $GgCO_2/PJ$ at a cost of $240 million, or $20 million per Gg, in the expectation of selling the

[12] About 1,750 sleeping villagers died in 1986 when the volcanic lake on Cameroon's Mount Nios produced a cloud of carbon dioxide that drifted down the mountain and killed the villagers as they slept. This was many more than the 36 or so who died at Chernobyl just a few months earlier. In 1979, an explosion at Dieng volcano in Indonesia released 200,000 tonnes of CO2, smothering 142 people on the plain below. Any gas at concentrations approaching 1 million ppm is highly dangerous, apart from oxygen.

resulting ETS credits for $240 million. It begins this project, but finds that it cannot sell enough credits to recover its costs, so it limits its project to the credits it knows it can sell, perhaps to the oil refinery industry. Trade takes place, and no net emission reductions accrue. If on the other hand, it persists with the project, its generation of more ETS credits that it can easily sell leads to a fall in the price of the credits, which will encourage many emitters to emit more than before, because the new price of credits has fallen even further below the cost to them of reducing their own emissions.

Again, at the point of trade there has by definition to be equality. The whole process is redolent of inefficiency and exorbitant transaction costs. It has to be far better for governments, having taken on themselves the duty of avoiding "dangerous climate change", to put their money where their mouths are, by directly subsidising – paying bounties – to those enterprises that do succeed in reducing their emissions, in our example the coal power sector, which with an offer of $240 million (or whatever it costs) will gladly undertake its emission reductions. At the same time, seeing this, the oil refineries instead of buying ETS credits that enable them to increase their emissions, would soon cast around for emission reductions that enabled them to claim compensatory bounties. This really would be a win-win for the environment, unlike the ETS trade, which for any given level of caps, is always zero-sum, as it allows as many above-cap emissions as the below-cap saved emissions. Public debt instruments should fund the total cost of these bounties, as the benefit will only be reaped by future generations' enjoyment of avoided climate damage.

The same principles apply to any putative worldwide ETS. Above all, cross border sales and purchases of credits will produce no net reductions in emissions, and Bali showed the unlikelihood of many countries accepting enforceable caps. At best, it will transfer emissions saved in say Australia to say major emitters in China, with the only measurable impact being an increase in their cost base. Does one have to be a cynic to see that this is most likely the real if hidden agenda of the EU and those in the USA (cited in the Garnaut lecture) also looking forward to pricing China's industry out of European and American markets? Far better if the EU is sincere about global emission reduction is for it to extend the bounty programme I advocate to countries like China, which it could well afford to do. For example, Germany could instead of closing its nuclear power industry by 2020 as planned, at least transfer it *gratis* to China. But the rulers of the EU's largest economy are no more sincere than an Australian government that refuses to allow nuclear energy to replace coal-fired power stations when the former is the only realistic and cost-effective alternative source of base load power. Germany is now building 36 new brown coal power stations, a rate rivalling China's, *pro rata*, while decrying the latter's and through the EU threatening trade sanctions against Chinese industry.

Coase's discussion of the optimal level of carbon taxes ends with his conclusion that "the aim of such regulations [e.g. Kyoto II] should not be to eliminate smoke pollution [read CO_2] but rather to secure the optimum amount of smoke pollution, this being the amount which will maximize the value of production" (1988:153). Stern, despite occasional mentions of Coase, made no effort to determine the optimum level of emissions relative to maximizing the value of production, and his preferred target of 80 per cent below the 2006 level is not only arbitrary but also relates just to stabilization of the atmospheric concentration "at whatever level" (2007:xvi). The Garnaut Review needs to do better if it is not to be just another political charade like

the Stern Review, and that will require determination of the optimal level of emissions founded on more than just a belief that today's is the best of all possible worlds.

An excellent exposition of the Coase criterion is that by Brookes (2004) who also invokes Jevons (once an employee of the Mint in Sydney c. 1860). There is no doubt that an ETS violates the Jevons-Coase criterion that what is required is not the *cost-effective* measures to reduce energy use that are the rationale of an ETS, "based on totals [of] expenditure on energy saving as against total value of energy saved" - but *optimizing* of energy usage based on incremental relationships (see also Tol and Yohe 2006). Nothing in the Stern Review discusses Jevons-Coase optimality. Will the Garnaut Review do better?

It is interesting to note that both the EU Commission and the Bush administration are resorting to mandatory limits – *with no emission trading* - for securing emission reductions from the motor vehicle industry. They are launching mandatory maximum emission standards (in terms of either minimum mileage per gallon or maximum carbon emission rates per litre of fuel) with fines for delinquency. Again it is easy to see that a system of cap and trap would be laughable for the motor industry, if say Holden bought credits generated by Toyota's Prius to enable its Commodores to continue to be sold, for yet again zero net emission change. But these arbitrary limits on fuel consumption may not be consistent with the Coase criterion for determining the optimum level of vehicle fuel pollution, being that amount "that will maximize the value of production". No wonder Germany's Daimler, Audi, and BMW are pressuring their government to resist the EU proposals, presumably because they believe those will prevent them maximizing the value of their production.

It is therefore to be hoped that the Garnaut Review will do better than Stern's, but it will not, if it relies on cap and trade to meet the myopic demands at Bali for long term cuts of up to 95 per cent in emissions, to levels far below the current uptakes of atmospheric carbon dioxide.

Auctioning of ETS Permits

The examples above assumed in effect that no permits had been issued *ab initio*, for the very good reason there is no reason why they should be. Yet the UK and EU versions of ETS, and the putative Garnaut version, all assume that there has to be such an initial allocation. What on earth for? All that is necessary for an ETS to start up is just the setting of caps. After that, trading will begin spontaneously provided the caps are rigorously enforced (and that is a big IF) but with an allowance for bought credits. But in their superior wisdom, the British and the EU decided to distribute emission credits like confetti, free of charge. The outcome was, as Garnaut rightly notes, huge profits for UK power generators at the expense of electricity consumers, and in the EU, a price for credits that early in 2007 fell as low as one Euro per tonne of carbon reduction credit.[13]

[13] Stern's Review (2007) devoted its chapter 15 to "Carbon Pricing and Emissions Markets in Practice" but was unable to cite any achieved reduction in net emissions. Stern implicitly equates growing trading volumes with emission reductions but this is invalid: all the trades involved nil net reductions. The only reductions noted are with respect to the carbon *tax* in Norway (Box 15.4).

The Garnaut proposal for auctioning of permits is also a double whammy. What it appears to envisage is that first, say, the power generators would bid for credits that would enable them to avoid having to reduce emissions, and that they would then offer for sale such credits as they did not need if they did succeed in somewhat reducing their emissions. So one sequence is: buy permits, at say \$100 per $GgCO_2$/PJ, then reduce emissions at say \$200 per $GgCO_2$/PJ, in the hope of selling ETS credits at \$300 per $GgCO_2$/PJ in order to recover costs. But who would buy these credits if they had already paid \$100 per $GgCO_2$/PJ for an initial allocation at auction? Meantime if the oil refiners abstained from the auction, and managed to reduce their own emissions at \$200 per $GgCO_2$/PJ, they would see no merit in paying the coal-fired power stations \$300. The auction is clearly a waste of time and money. Better to set caps, and let trading begin. But much better by far is to avoid the whole charade, even if to the chagrin of ASX, ANZ, Westpac, Macquarie Bank, and Goldman Sachs, and pay the major emitters whatever it costs them to reduce their emissions. As shown in my Table 1, fixing emissions from coal-based power industry effectively fixes them for the whole economy (*pace* the IPCC).

The Platinum Age

Garnaut's lecture stated "the acceleration of global economic growth would be an unambiguously good thing if it were not for the inconvenient truth, that the scaling up of the patterns of life of the developed countries to the populous parts of the developing world is not sustainable without major changes in the relationship between economic activity and the environment". There is no basis for that statement, since self-evidently the developed countries achieved "their present patterns of life" without until now any "major changes in the relationship between economic activity and the environment". For manifestly there is as yet no certified climate change damage anywhere in the world, at a time when global economic growth has never been faster, even, as Garnaut noted, in sub-Saharan Africa. Economic activity has always been both reactive and proactive with the environment, and there is no reason why that should not be the case in the future. Famously, it has always staved off the terminal decline that would result from dominance of high entropy by use of low entropy to maximise social product. Regrettably the whole IPCC process is dedicated not merely to ending Garnaut's Platinum Age but also all life by the abstention from low entropy.[14]

This is made crystal clear by Sir John Houghton, a main author of the first two, and lead author of the third Report (TAR) of the IPCC. He has said: "Suppose, for

[14] "Entropy" is yet another word you will not find in the Stern Review, the IPCC's AR4 and its associated Working Group Reports, or in Ross Garnaut's Lee lecture. For full accounts see Georgescu-Roegen (1971) and Beinhocker (2007). Martin Wolf, a noted supporter of the Stern Review, has belatedly woken up to the dangers of reversing the positive-sum world economy of the last 250 years, see his "The dangers of living in a zero-sum world economy", *Financial Times*, 19 December 2007. Fred Hoyle as ever prescient noted in 1981 that "if carbon dioxide were entirely removed from the atmosphere the radiating efficiency of the Earth's surface would rise from 60 per cent to 75 per cent, [and] the average temperature of the Earth would fall to 270K (-3^{o}C) [along with] a catastrophic reduction in the growth of vegetable material, leading in turn to extinction of animals of all kinds" (1981:122-123) (see also Curtin 2007, Annex I below).

instance, that all emissions into the atmosphere from human activities were suddenly halted. No sudden change would occur in the atmospheric concentration, which would decline only slowly. We could not expect it to approach its pre-industrial value for several hundred years" (2004:39). This preposterous prediction assumes the present net uptakes of CO_2 of 5 GtC p.a. would cease as soon as "all emissions …were suddenly halted". It also contrasts with my own calculations (2007) that if uptakes just continue at the rate for 2000-2006 of 5 GtC p.a. (Canadell *et al*., 2007) while emissions are reduced only by Stern's 80 per cent, to less than 1 GtC p.a., not Houghton's 100 per cent to nil, it could take as little as 50 years for the atmospheric concentration of CO_2 to fall to the level in 1750 (280 ppm) (see Fig.2 in Curtin, 2007, attached here as Annex II). On the other hand, if the net uptakes do cease, as claimed by Houghton, that implies termination of the net photosynthesis that has contributed so much to raising the growth of agricultural yields over the last 250 years, and a return at best to the stagnation of real incomes in all previous millennia before 1800 (Hoyle 1981, Maddison 2003).

An inconvenient variant of Houghton's claim is that "if atmospheric CO_2 levels were suddenly decreased, then the ocean would slowly leak carbon dioxide back to the atmosphere, acting to push the climate back to its previous state" – another zero-sum game (Bigg 2003:101). This is a warning of the dangers of anthropogenic tinkering with the climate – climate policy can have its own extremely dangerous feedbacks.

The near-total absence of discussion in the IPCC's AR4 of the net uptake rate of carbon dioxide (it is wholly absent from WG3, ch13, which was the basic text for the Bali Action Plan, and receives only a couple of pages in WG1, ch.7) results in part from a tendency of biogeochemists to think in terms of equilibrium flows, with photosynthesis (uptakes) sooner or later matched by respiration (emissions). They argue accordingly (like Houghton) that if net emissions ceased, then the resulting equilibrium would maintain life at its present level. But even if present growth of world population ceased, there would remain the insatiable demand of all (except the likes of Bill Gates) for an ever higher standard of living, including more meat eating in China, India and Africa, just one example of growing demands on cereal production and thus on photosynthesis (another is the determination of the USA to replace much of its oil consumption with bio-fuels with their huge requirement for the photosynthesis by carbon dioxide that will become scarcer with adoption of solar and wind power).

Other scientists claim that the "basic physics" is such that if net emissions ceased or turned negative, uptakes would drop to restore "balance", on the basis that with zero emissions, the fall in the partial pressure of atmospheric carbon dioxide would prevent further uptakes.[15] Why this would be good for humanity is far from clear. There is no doubt that the present level of uptakes is associated with all time high world food production. Would its growth continue without rising atmospheric carbon dioxide? Such issues are never raised in the "science" of the IPCC.

[15] It is more complicated than that. While it true that aqueous CO_2 increases/reduces linearly with the partial pressure of CO_2 as that increases/reduces with the atmospheric concentration, if temperatures fall following reduction of the atmospheric, then the amount of dissolved CO_2 - the oceanic uptake - also increases (Liss and Crane 1983).

The FACE ("free-air CO2 enrichment") field experiments have confirmed the large fertilizing effect of elevated carbon dioxide levels even in open fields. The experiments use pipes to release jets of CO2-enriched air or pure CO2 gas into the fields: "exposure to elevated CO2 resulted in a 31% increase in the light-saturated leaf photosynthetic rate and a 28% increase in the diurnal photosynthetic rate carbon assimilation when averaged across all FACE experiments and species". Trees showed the greatest response, followed by fertilized C3 crops (e.g. wheat) Thus trees showed a 28% increase in above-ground dry matter production, but crop yields increased by "only" about 15-17% (wheat farmers in Victoria would be quite content with that) (Ainsworth and Long, 2005:354-5, 358).

Moreover, many studies (e.g. Stoy 1965) have demonstrated that yields of plant products grown in greenhouses can be increased by 20-40 per cent by enriching the air inside the greenhouse with carbon dioxide. The target level for enrichment is typically a carbon dioxide concentration of 1000 ppm (parts per million) - or about two and a half times the present level in the atmosphere. The nuisance is that while the oceans hold about 50 times more CO_2 than the atmosphere, "neither air nor the oceans have great enough concentrations to make them commercially viable sources of CO_2" (UIG, 2007). Thus the major source of carbon dioxide for such industrial purposes is from its output as a *by-product* of all the various industrial processes that the Australian Conservation Foundation (ACF) would like to see banned. Its – and it has to be said so far the Rudd government's - simplistic view is that all carbon dioxide is evil, and should be abolished.

Indeed, pushed to the limits proposed by the ACF, with its powerful policy advocacy within the ALP and now the Government, all production of carbon dioxide would cease. For example, Ian Dunlop, Chairman of the Australian National Wildlife Collection Foundation and deputy convener of the Australian Association for the Study of Peak Oil, writing in the *Australian Financial Review* (2 January 2008), looks forward to "close to 100 per cent de-carbonisation by 2050". This would bring to an end CO_2's widespread use as refrigerant (where it has helped to replace ozone-depleting CFCs), in fire extinguishers, fertilisers in greenhouses, and as an essential ingredient in all carbonated soft drinks. In particular the ACF's drive to push up energy prices, whether by ETS or carbon taxes, would make carbon dioxide enrichment for greenhouses more costly. The various CO_2 generators on the market (e.g. the Johnson Gas Generator) use propane or natural gas to produce CO_2 which is ducted into greenhouses, especially when around mid-morning the internal concentration of CO_2 in a greenhouse drops to as low as 100-150 ppm, causing plant growth to cease.

Evidently the ACF and its fellow travellers are unable to distinguish between carbon dioxide emitted in the process of power generation and what is emitted in the process of *using power* to produce manufactured and agricultural products. The latter emissions will still arise even if windmills produce all the power used in producing electricity.

Here is a reality check. Australia's official National Greenhouse Accounts (as submitted to the UN by the Australian Greenhouse Office 2006) are summarised by economic classification in Table 1. They show that in 2005 more than a third of total carbon dioxide emissions was in the electricity, gas, and water sector.

The final column shows the required level in 2020 (allowing for the Government's target announced at Bali of emission reductions of up to 40% of the 1990 level) as percent of the actual 2005 level. Thus it appears that mining will be allowed to emit only 40-41 per cent of its 2005 level, and manufacturing 58 per cent, while the reduction for the electricity, gas and water sector would have to be nearly 60 per cent (not the Government's offer of 40 per cent at Bali). These would presumably be their respective "caps" if an overall reduction of 40 per cent is to be attained.

Table 1
Direct Greenhouse Gas Emissions

MtCO2-e	**1990**	**2005**	**Growth 1990-2005**	**Shares % in 2005**	**1990 @ 60% in 2020**	**2020 as % 2005**
Total	547.20	559.10	2.17	100	328.3	58.72
Total, excluding agriculture	327.10	430.90	31.73			
Agriculture, Forestry and Fishing	220.10	128.20	-41.75	22.9	132.1	103.01
Mining	32.00	46.30	44.69	8.3	19.2	41.47
Manufacturing	67.10	69.00	2.83	12.3	40.3	58.35
Electricity gas & water	135.50	199.00	46.86	35.6	81.3	40.85
Commercial services & distribution	22.00	22.20	0.91	4.0	13.2	59.46
Transport and storage	27.20	38.70	42.28	6.9	16.3	42.17
Residential	43.30	55.70	28.64	10.0	26.0	46.64

Source: Australia's National Greenhouse Accounts 2006 (the 40% target reduction for 2020 from Bali Action Plan)

Table 1 also shows the deception of the IPCC/Bali emission reduction targets, because nowhere do the IPCC or the NGOs and media disclose that reductions based on 1990 or even 2000 levels are much more onerous than the headline level when applied to actual 2005 levels. To repeat, the electricity gas and water sector in Australia would actually have to reduce its 2005 emissions by *60 per cent* (i.e. **to** 40 per cent **of** the 2005 level) to achieve the mandatory 40 per cent reduction **from** the 1990 level. If the Rudd team at Bali knew this, they gave no hint that they did.

But the game may be even more complex than this. If the electricity industry meets its target, should that not count towards attainment of the target for manufacturing, given that it would be using power the production of which was emitting 40 per cent less carbon dioxide than in 1990? More pertinent, if the power sector achieved its 40 per cent reduction from the 1990 level, should that not exempt households from being obliged to install solar heating and the like, since *ipso facto* they would also be emitting 40 per cent less than in 1990? But if that is allowed, it will not help Australia to reach its agreed Bali target of up to 40 per cent of *total* 1990 emissions, as that does not allow the *use* of lower emission electricity to count. Note that the *Summary for Policy Makers* of AR4 WG III refers to "direct emissions" as *not* including "emissions from the electricity sector for the electricity consumed in the building, industry and agriculture sectors or of the emissions from refinery operations supplying fuel to the transport sector" (2, fn3). This begs the question of whether only "direct emissions" should necessarily be the basis for emission reduction targets, as WGIII seems to imply. Note also that its *Summary for Policy Makers* explicitly rejects any allowance for carbon uptakes (removals) in the "land use, land use change and forestry" sector (2, fn.4) – and this is its only reference to uptakes.

However, even if all electricity were to be produced by renewable energy, the aluminium industry would still be generating carbon dioxide in its smelters. Rio Tinto's Aluminium operations increased their emissions of CO_2e from 166,486 tonnes in 2004 to 973,977 tonnes in 2006 (2007). Had the ALP won the 2004 election and introduced emissions caps and trading, presumably the expansion of output leading to these growing emissions could only have happened if Rio had bought credits. Even if the carbon dioxide price that emerged from the ETS was only A$30 per tonne of CO_2e (A$8.17 per tonne of carbon), Rio would have had to buy credits costing A$25 million p.a. (assuming the cap had been set only at 80% of the 2004 level), equal to 10 per cent of its capital expenditure in 2006, or 3.38 per cent of net earnings in 2006. Given that the ETS credits would have to be purchased every year, it would not take long for Rio to determine that piping the CO_2 into Gladstone harbour was more cost effective. It would moreover be able to recover the cost of this by selling the resulting earned credits to those with less easy disposal options.

Alternatively, under ETS the aluminium industry would be able to buy emission credits from the power sector, but the cost of its activities would rise by both the unavoidably (at present indications) higher price of renewably generated electricity and the cost of the mandatory purchased credits. This double whammy could be expected to result in serious consideration by say Alcoa and Rio Tinto of relocation options for their smelters - for Rio to say Kyoto- and Bali-exempt Papua New Guinea, with its many sites conveniently close to both the hydro potential of the Purari River and the LNG of the PNG gasfields, as well as the weekend comforts of Queensland for its top management. However, as appears to be envisaged in Ross Garnaut's Lee Lecture (2007), there would be every incentive though ETS for Rio Tinto to incur the fairly minor costs of piping CO_2 captured from its Boyle smelter into the sea at Gladstone, virtually guaranteeing wipe out of the Great Barrier Reef.

If emissions of water are a major greenhouse gas, why are they not included in Emissions Trading Schemes?

None of the proponents of ETS suggest that it should cover H_2O as well as CO_2, even though the atmospheric volume of water is both larger than that of CO_2 and has a larger proportionate greenhouse effect. Note that the emissions index for jet engines is 3.15 kg of CO_2 and 1.26 kg of H_2O per 1 kg of fuel (see *Aviation and the Global Atmosphere*, Penner et al., IPCC, CUP, 1999:33). The residence of the H_2O emissions in the atmosphere is about 9 days (ibid:23), implying that it soon produces rain. The CO_2 is mostly emitted in the stratosphere which is well known to be cooling (see AR4, *passim*). Will aviation be included in the Garnaut ETS? If not, why not, if water vapour is indeed a greenhouse gas as the IPCC claims? But then Garnaut's Lee lecture claimed that it is greenhouse gas climate change that is reducing rainfall in S.E. Australia. If that is so, how will reducing emissions of water vapour help? Petrol emissions also contain large proportions of water and CO_2. Even propane (LPG), regarded as relatively "green", has this formula:

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4\ H_2O$$

So aviation and car fuels both emit lots of water and carbon dioxide, and each is essential for life as we know it. Even the IPCC (2007, WG1, ch.3:238) admits that for most of the globe "it has become significantly wetter in eastern parts of North and

South America, northern Europe, and northern and central Asia". As these areas exceed in extent the areas where allegedly it has become drier, it seems likely there has indeed been an increase in total terrestrial precipitation. That is also implied by the fact "tropospheric water vapour is increasing" – in line with the increases in surface humidity since 1976, associated by the IPCC with the slight global warming since then (less than 0.7^{o}C) (ibid.) Moreover "total column water vapour has increased over the global oceans by 1.2 +/- 0.3% per decade from 1988 to 2004" (ibid.). If the IPCC is right that this increases the greenhouse effect (ibid.), then water emissions should be included in ETS, but what if the water vapour is a cause of the increased overall global precipitation, especially as the areas with enhanced rainfall account for the majority of the world's population? Again, recall that windmills and solar panels have none of the beneficial (and free) by-products (water and carbon dioxide) that maintain the low entropy of fossil fuels, whilst remaining substantially more costly per unit of energy than the latter.

Carbon Capture and Storage (CCS)

Ross Garnaut's Lee Lecture gave some prominence to CCS as perhaps the best option for cost-effective emission reduction. The IPCC's Special Report on CCS (Metz *et al.,* 2005) suggests some caution is needed. The costs of capture from a coal or gas-fired power plant could be as low as US$40 /tCO2 captured, or as high as US$90, in part because there would be large extra demand for power with its associated extra emissions (as much as 40 per cent) to effect the CCS (ibid., 10); the impact on electricity prices would similarly range from 50% to 100% (US$ per kWh), ibid., Table SPM.3.

These price effects are as nothing compared with the environmental impact of the IPCC's suggestion that much storage of captured carbon would have to be in the oceans, where even at only 10 per cent of the mitigation effort it would raise acidity (decrease pH) by more than 0.4 over about one per cent of the total ocean. This is much more than the 0.1 fall in pH since 1750 claimed by the IPCC's WG I to be already having adverse impacts. The most optimistic estimate of the "technical potential" of storage capacity in geological formations on land is 545 GtC (Metz et al., 2005:11). That is enough to store just 72 years of the average annual fossil fuel emissions in 2000-2006, *so that by 2080 there would be no land storage available, and more would have to be dumped in the oceans.*

Localised effects of dumping carbon dioxide at 1 million ppm into the ocean would have to be considered, as unlike the particulate waste piped into the sea at Misima and Lihir Mines in Papua New Guinea, dissolved carbon dioxide diffuses both laterally and longitudinally. The Garnaut ETS would in effect finance dumping of carbon dioxide captured from Rio Tinto's aluminium operations in Gladstone into the sea there – resulting in newspaper headlines such as **"Rudd's Emission Trading destroys the Barrier Reef"** that would perhaps be too interesting for comfort.

The safety issues of storing carbon dioxide at one million ppm were noted above, but are largely glossed over by both the Garnaut lecture and the IPCC's Metz et al. (2005:11-12). The latter do at least admit that "pressure build-up caused by CO_2 injection could trigger small seismic events" without mentioning that large seismic events, like that at Newcastle about 15 years ago, could lead to sudden eruptions of

the stored CO_2, possibly killing millions if repeated in say the Hunter Valley. In general, it is fair to say that in the Metz Report the IPCC plays up the damage notionally being caused by an atmospheric concentration of less than 400 ppm and plays down the local damage potential of concentrations of one million ppm.

Regression analysis

To a mere economist, one of the oddest features of the whole IPCC reportage is the almost total absence of any multi-variate statistical analysis. To take the most obvious case, we have both undeniable year-by-year increases in the measured atmospheric concentration of carbon dioxide since 1958, with much more variable changes in "global" temperature (whatever that may mean), yet we are asked to believe (by our governments and the IPCC) that there is in effect a one-to-one relationship. Table 2 below is the report on my, no doubt, simple-minded regression of the latter against the former. It shows there is indeed a strong relationship between carbon dioxide emissions and apparent temperature anomalies, but even so the adjusted R^2 at 0.7 implies that there are other rather important influences that account for up to 30 per cent of the temperature anomaly. A second naïve regression (Table 3) treats the FAO index for world food crop production from 1980 to 2003 as a function of the atmospheric concentration of carbon dioxide at Mauna Loa since 1980 and the temperature anomalies reported by NASA/GISS. Here the R2 is 0.98, and only the coefficient on carbon dioxide is statistically significant (at the 95% level). This result confirms the finding by Stoy that "CO_2 is a minimum factor at least at medium and high light intensities and that even a very moderate increase of its external concentration raises the rate of photosynthesis appreciably" (1965:108). With all its resources, surely the IPCC could produce similar – but more refined - statistical analysis?

Table 2

Temp anomaly = f(change in CO2 p.a.)
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.846165
R Square	0.715995
Adjusted R	0.703647
Standard E	11.02462
Observatio	25

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	1	7047.568	7047.568	57.98452	9.9E-08
Residual	23	2795.472	121.5422		
Total	24	9843.04			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Jpper 95.0%*
Intercept	-459.9015	65.85407	-6.983647	4.06E-07	-596.1309	-323.6722	-596.1309	-323.6722
X Variable	1.391634	0.182755	7.614757	9.9E-08	1.013578	1.769691	1.013578	1.769691

Table 3

Regression: Food= f(temps anomaly, CO2)
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.994889
R Square	0.989803
Adjusted R	0.988783
Standard E	1.963945
Observatio	23

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regressior	2	7488.107	3744.053	970.6962	1.22E-20
Residual	20	77.14161	3.85708		
Total	22	7565.248			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*
Intercept	-492.648	19.56336	-25.18218	1.28E-16	-533.4564	-451.8396	-533.4564
338.34	1.752006	0.057467	30.48721	3.06E-18	1.632132	1.87188	1.632132
28	-0.046075	0.034095	-1.351374	0.191665	-0.117196	0.025046	-0.117196

CONCLUSIONS

> *The fundamental reason why carbon dioxide in the atmosphere is critically important to biology is that there is so little of it. A field of corn growing in full sunlight in the middle of the day uses up all the carbon dioxide within a meter of the ground in about five minutes.* (Freeman Dyson 2007)

It is fair to suggest that almost all of the IPCC's publications since 2000 if not before would fail to meet the minimum criteria for an IPO (Initial Public Offering) on the Australian Stock Exchange. This is documented in detail in Curtin 2008 which describes the widely differing estimates by a group of the IPCC's Nobel Prize winners of the relative contributions of the oceans and the landmass to the earth's uptakes of atmospheric carbon dioxide. If "The Science" is settled, why is the IPCC still unable to provide precise *measurements* of the role of clouds as either positive or negative feedbacks of "global warming", or of land use change impacts, or of the partitioning of the undoubted huge global uptakes of atmospheric carbon dioxide between the oceans and the land mass? Its own lead authors – e.g. CSIRO's Canadell and Raupach *et al.* - vary the relative proportions almost monthly, with scant regard for normal definitions of rates of growth of atmospheric carbon dioxide and other variables.

Otherwise, the main conclusions of this Submission are:

1. Emission reduction targets should take into account terrestrial and oceanic uptakes of carbon dioxide, which have for nearly 50 years absorbed an increasing fraction (currently over 55 per cent) of global emissions. That means such targets should never reduce emissions to below the *current* level of global uptakes.
2. Only a sustained programme of annual *across the board* cuts in carbon emissions will achieve the targets of the Australian Government and the aspirations of the Bali Action Plan.
3. There should be no presumption in favour of establishing an Emissions Trading System - in general an ETS creates only zero sum outcomes, i.e. no net reduction in emissions, as is evident from Stern's account of the EU record (2007).
4. If there is to be an ETS, there is no need for either free distribution of initial permits or credits, or auctioning of such permits: all that is necessary is for setting of caps, with exemptions for emissions covered by bought credits, and then trades will begin spontaneously.
5. One of the little recognized dangers of an ETS is that it may well promote methods of CO_2 disposal, like CCS with its encouragement for dumping on land and in the ocean, that are far more environmentally dangerous than the original emissions.
6. However, although almost all economists affirm the greater efficiency of taxation, and both the Bush administration and the EU are relying on caps alone, without trading, to regulate emissions from automobiles, it is far preferable to adopt the Coase recommendation (following Fortes) for direct payment of bounties to those who commit to reducing emissions (reimbursing the costs thereof), as this is more efficient than either taxes or permit trading,

and only this would encourage China and India to join in global emission reduction targets of a Kyoto II.

7. Public debt instruments should be used to fund such bounties, as the benefits of avoided climate damage will wholly accrue to future generations.

Finally, it is to be hoped that the Garnaut Review will at least seek expert advice on whether stabilising atmospheric carbon dioxide at say 450 ppm by 2020 will have a beneficial impact on world food production in a context of still rising population, already record levels of wheat, corn and soya prices, and Platinum Age expectations. Those advisers will need to consider first, whether replacing so-called fossil fuel emissions of water and carbon dioxide with emission-free solar and wind energy, or even nuclear, will be an unmixed blessing, and secondly, whether the benefit:cost ratio of boosting photosynthetic uptakes does or does not far exceed that for reducing "greenhouse gas emissions".

Acknowledgments

I am indebted to Ray Evans for detailed comments and for encouragement from Freeman Dyson, Graham Farquhar, Barry Ninham, and Pamela Swadling. All remaining errors are mine.

Bibliography

Ainsworth, E.A. and S.P. Long 2005. What have we learned from 15 years of free-air CO_2 enrichment (FACE)? *New Phytologist*, 165: 351-372.

Australian Greenhouse Office 2006. *Australia's National Greenhouse Accounts*. AGO, Canberra.

Beinhocker, Erid D. 2007. *The Origin of Wealth*.Harvard Business School Press, Cambridge, Mass.

Bigg, G. 2003. *The Oceans and Climate Change*. CUP, Cambridge.

Brookes, L. 2004. Energy efficiency fallacies – a postscript. *Energy Policy*, 32.8, 945-947.

Canadell, J. and C Le Quéré, M.R. Raupach, C.B. Field, E.T. Buitenhius, P. Ciais, T.J. Conway, N.P. Gillett, R.A. Houghton, G. Marland 2007a. Contributions to accelerating atmospheric CO2 growth from economic activity, carbon intensity, and efficiency of natural sinks. *Proceedings of the National Academy of Science of the USA*, October 25, 2007.

Canadell, J., and P. Ciais, T. Conway, C. Field, C. Le Quéré, S. Houghton, G. Marland, M. Raupach, E. Buitenhuis, N. Gillett 2007b. *Recent Carbon Trends and the Global Carbon Budget*. Global Carbon Project, Canberra.

CDIAC 2007. see Marland *et al.* 2007

Coase, R.H. 1960. The Problem of Social Cost, in Coase 1990.

Coase, R.H. 1990. *The Firm the Market and the Law*. University of Chicago Press, Chicago and London.

Denman K.L. et al. (including P. Ciais, P.M. Cox, P. Bousquet, J. Canadell, P. Friedlingstein, C. Le Quéré, M. Raupach, and W. Steffen) 2007. Couplings between Changes in the Climate System and Biogeochemistry, in WGI 2007.

Dyson, F. 2007. *A Many-colored Glass. Reflections on the Place of Life in the Universe.* University of Virginia Press. Charlottesville and London.

Feinstein, C.H. and M. Thomas 2002. *Making History Count*. CUP, Cambridge.

Field, C.B. and M. Raupach 2004 (eds.). *The Global Carbon Cycle*. Island Press, Washington DC.

Garnaut, R. 2007. *Will climate change bring an end to the Platinum Age?* Inaugural S.T. Lee Lecture.

Georgescu-Roegen, N. 1971. *The Entropy Law and the Economic Process*. Harvard University Press, Cambridge, Mass.

Hansen, J. and M. Sato 2004. Greenhouse gas growth rates, *Proceedings of the National Academy of Science*, November 16, 2004, vol.101, 46, 16109-16114.

Houghton, J. 2004. *Global Warming. The Complete Briefing*. CUP, Cambridge.

Hoyle, F. 1981. *Ice*. Hutchison, London.

Humphreys, J. 2007. *Exploring a Carbon Tax for Australia*. CIS, Sydney.

Keeling, C.D. and T.P. Whorf 2007. *Atmospheric CO2 concentrations (ppmv) at Mauna Loa.* Carbon Dioxide Research Group, Scripps Institute of Oceanography (SIO), from http://cdiac.ornl.gov/ftp/trends/co2/maunaloa.co2

Liss, P.S. and A.J. Crane 1983. *Man-made carbon dioxide and climatic change*. Geo Books, Norwich.

Lomborg, B. (ed.) 2004 *Global Crises, Global Solutions*. CUP, Cambridge.

Lomborg, B. 2007. *Cool it. The Skeptical Environmentalist's Guide to Global Warming.* Marshall Cavendish, London.

Marland, G, T.A. Boden, R.J. Andrews 2007. *Trends; a compendium of data.* CDIAC, Oak Ridge (availble at http://cdiac.ornl.gov/trends/

Metz, B. et al. (eds) 2005. *Carbon Dioxide Capture and Storage. IPCC Special Report. Summary for Policy Makers.* IPCC, WG III.

Nicholls, R.J. and R.S.J. Tol 2006, 'Impacts and responses to sea-level rise: A global analysis of the SRES scenarios over the 21st Century', *Philosophical Transactions of the Royal Society A – Mathematical, Physical and Engineering Sciences*, **361** (1841), 1073-1095.

Nordhaus, W.D. and J.G.Boyer 2000, *Warming the World: Economic Models of Global Warming* The MIT Press, Cambridge, Massachusetts.

Penner, J.E., D.H. Lister, D.J. Griggs, D.J. Dokken, M. McFarland 1999. *Aviation and the Global Atmosphere.* IPCC, CUP, Cambridge.

Rio Tinto 2007. *Annual Report and Financial Statements 2006.* Rio Tinto Limited, Melbourne.

Robson, A. 2007. *A Solution in Search of a Problem.* Lavoisier Group, Melbourne.

Shergold, P. 2007. *Report of the Task Group on Emissions Trading*. Australian Government, Canberra.

Stern, N. 2007. *The Economics of Climate Change. The Stern Review.* CUP, Cambridge.

Stoy, V. 1965. *Photosynthesis, respiration, and carbohydrate accumulation in spring wheat in relation to yield.* Physologia Plantarum Supplementum IV, Lund.

Tol, R.S.J. and G.W. Yohe 2006, 'Of Dangerous Climate Change and Dangerous Emission Reduction' in H.J. Schellnhuber, W. Cramer, N. Nakicenovic, T. Wigley and G. Yohe (eds.), *Avoiding Dangerous Climate Change*, Cambridge University Press, Cambridge, Chapter 30, pp. 291-298.

UIG (Universal Industrial Gases) 2007. *Carbon Dioxide Properties, Uses, Applications.* UIG, Easton PA. (available at www.uigi.com/carbondioxide.html)

WGI (Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change) 2007. *Climate Change 2007. The Physical Science Basis*. CUP, Cambridge.

WGIII (Working Group III Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change) 2007.

A NOTE ON DATA SOURCES

My Fig. 1 uses the data on the atmospheric concentration of carbon dioxide at Mauna Loa that is also used by Canadell et al. (if only to 1980, from when they also use some data from other areas). The Mauna Loa data is provided here in Table 4 below. The Table also shows the data from the source cited by Canadell *et al.* (2007a) for both fossil fuel emissions and the land use flux. This source is the Carbon Dioxide Information Analysis Centre (CDIAC), available at www.globalcarbonproject.org. Contrary to statements by Canadell *et al.*, the fossil fuel series ended in 2004, and the land use series in 2000, when I accessed this site on 1st January 2008. However I took on trust the claim by Canadell *et al.* that growth of fossil fuel emissions averaged 3.3% p.a. from 2000 to 2006 to interpolate emission estimates for 2005 and 2006 (2007:1). Similarly I used their claim that land use emissions averaged 1.5 GtC from 2000 to 2006 (2007:Table 1) to interpolate values for this series from 2000.

These data yield a negative log linear growth rate for the Airborne Fraction of minus 0.10878% p.a.. It is for Canadell *et al*. to explain why their data sources yield an outcome opposite to that they proclaimed to the world.

Table 2

Atmospheric Carbon: Stocks and Flows

	Opening GtC	Emissions Inflow	Land use Change	Total Uptakes	Closing GtC	Closing ppm Mauna Loa	Airborne Fraction
1958	-	2.33	1.42	-	668.47	314.67	-
1959	668.47	2.46	1.32	1.83	670.42	315.59	0.79
1960	670.42	2.58	1.30	2.60	671.70	316.19	0.49
1961	671.70	2.59	1.41	2.26	673.44	317.01	0.67
1962	673.44	2.70	1.42	2.68	674.89	317.69	0.54
1963	674.89	2.85	1.44	2.87	676.31	318.36	0.50
1964	676.31	3.01	1.47	3.73	677.05	318.71	0.25
1965	677.05	3.15	1.49	3.13	678.56	319.42	0.48
1966	678.56	3.31	1.53	1.41	681.98	321.03	1.03
1967	681.98	3.41	1.53	2.97	683.96	321.96	0.58
1968	683.96	3.59	1.55	3.14	685.95	322.90	0.56
1969	685.95	3.80	1.56	2.77	688.55	324.12	0.68
1970	688.55	4.08	1.54	3.47	690.69	325.13	0.53
1971	690.69	4.23	1.42	3.78	692.56	326.01	0.44
1972	692.56	4.40	1.39	2.51	695.83	327.55	0.74
1973	695.83	4.64	1.42	3.74	698.15	328.64	0.50
1974	698.15	4.64	1.42	4.24	699.97	329.50	0.39
1975	699.97	4.62	1.43	3.37	702.65	330.76	0.58
1976	702.65	4.88	1.57	4.48	704.63	331.69	0.40
1977	704.63	5.04	1.61	2.86	708.41	333.47	0.75
1978	708.41	5.11	1.61	3.83	711.30	334.83	0.57
1979	711.30	5.40	1.63	3.04	715.29	336.71	0.74
1980	715.29	5.35	1.61	3.49	718.75	338.34	0.65
1981	718.75	5.19	1.71	3.60	722.05	339.89	0.63
1982	722.05	5.14	1.92	5.41	723.70	340.67	0.32
1983	723.70	5.13	1.98	2.29	728.53	342.94	0.94
1984	728.53	5.31	2.04	4.22	731.65	344.41	0.59
1985	731.65	5.46	2.07	4.96	734.22	345.62	0.47
1986	734.22	5.63	2.11	5.06	736.90	346.88	0.48
1987	736.90	5.76	2.13	3.33	741.46	349.03	0.79
1988	741.46	5.99	2.15	3.34	746.26	351.29	0.80
1989	746.26	6.11	2.15	5.41	749.11	352.63	0.47
1990	749.11	6.20	2.16	4.98	752.49	354.22	0.55
1991	752.49	6.31	2.38	7.07	754.10	354.98	0.26
1992	754.10	6.19	2.24	7.56	754.97	355.39	0.14
1993	754.97	6.20	2.22	5.64	757.76	356.70	0.45
1994	757.76	6.34	2.20	4.21	762.09	358.74	0.68
1995	762.09	6.49	2.17	5.04	765.70	360.44	0.56
1996	765.70	6.65	2.14	5.56	768.93	361.96	0.49
1997	768.93	6.84	2.11	4.36	773.52	364.12	0.67
1998	773.52	6.79	2.09	2.91	779.49	366.93	0.88
1999	779.49	6.80	2.07	6.83	781.53	367.89	0.30
2000	781.53	6.98	2.08	5.34	785.25	369.64	0.53
2001	785.25	7.12	**1.50**	5.49	788.37	371.11	0.44
2002	788.37	7.17	**1.50**	3.16	793.87	373.70	0.77
2003	793.87	7.50	**1.50**	4.18	798.69	375.97	0.64
2004	798.69	7.91	**1.50**	6.14	801.96	377.51	0.41
2005	801.96	**8.17**	**1.50**	4.25	807.38	380.06	0.66
2006	807.38	**8.44**	**1.50**	6.14	811.18	381.85	0.45

NB Figures in bold are from Canadell et al. 2007a;
the conversion factor for CO2 in ppm to GtC (2.124352) is from Canadell at al.(2007a: 1)
Sources: SIO, CDIAC
Log linear growth rate of the Airborne Fraction
-0.1088 % p.a.