Australia's Garnaut Report: A Review Article

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Prologue

The present world financial crisis has seen the great economist John Maynard Keynes making a comeback, with even a fiscal conservative like Kevin Rudd espousing Keynesian deficit finance. Keynes is also remembered for his remark that "madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back" (1936:383). That is an apt description of the climate change mantras that led to the appointment of the Garnaut Review, and the Review's *Final Report* itself exhibits frenzy distilled from not a few scribblers of the past, including T.R. Malthus, W.S. Jevons, and S. Arrhenius of the 19th century, down to Paul Ehrlich, the Club of Rome, and the IPCC's John Houghton, of the last, not forgetting James Hansen (of NASA's Goddard Institute of Space Studies, GISS) and his acolyte Al Gore.

Ehrlich and the Club of Rome confidently predicted exhaustion of all mineral resources by 2000 if not before, and the Garnaut *Report* merely extends the final date to 2100 (pp.69-71). Malthus earned fame with his theory that while population grows "geometrically", for example by doubling every 25 years, we would say exponentially, food production grows only "arithmetically", that is, by the same absolute amount in every time period. Arrhenius, who won a real Nobel in 1903, repeated this formulation in his celebrated paper of 1896 that remains the cornerstone of the anthropogenic global warming (or climate change) movement, by asserting that while *atmospheric carbon dioxide* (hereafter written [CO_2]) "increases in geometric progression, augmentation of the temperature will increase in nearly arithmetic progression". Arrhenius then calculated that if [CO_2] increased by 50 percent from the level in 1896, global average temperature would increase by between 2.9 and 3.7°C, depending on season, latitude and hemisphere, with a global annual mean of 3.42°C. The level of [CO_2] has nearly increased by 50 percent since 1896 – sooner it is true than Arrhenius expected – but global temperature according to GISS had by 2008 increased by just 0.73°C since 1896.

It is well known that Malthus has long since been proved wrong about food production, which has grown exponentially even faster than world population, so that the recurring starvation and population wipe-outs that Malthus feared have yet to materialize. Evidently Arrhenius has been nearly as mistaken, but in a different direction, with global temperature growing almost imperceptibly relative to the near 50 percent growth in [CO_2]. Yet the Garnaut *Review* endorses the claim by the Intergovernmental Panel on Climate Change (IPCC) in its latest Report (2007) that if [CO_2] doubles from the level in 1896 (270-280 parts per million, ppm) to 560 ppm, global temperature will rise by between 1.5 and 4°C, with a central estimate of 3°C, the latter being 4 times the observed increase of 0.73°C for the near 50 percent rise in [CO_2] since 1896. Yet Arrhenius had calculated that doubling [CO_2] from the 1896 level would raise annual global mean temperature by 5.5°C, just 1.6 times more than his estimate for an increase of [CO_2] by 50 percent. Thus the *Review* and the IPCC (*Solomon et al.* 2007:12) predict an *acceleration* of temperature increase with respect to increasing [CO_2], despite also asserting that the relationship is logarithmic rather than exponential, or, as the *Review* puts it, using terminology close to that of Arrhenius, "CO_2 added later will cause proportionately less warming than CO_2 added now" (p.37).

This is an extraordinary contradiction given that the Garnaut *Review* as a whole is dedicated to the proposition that global warming will accelerate unless CO_2 emissions are subjected to

draconian reductions, by as much as 80 percent of the 2000 level in Australia. But as we shall see, the *Report* has more equally bizarre contradictions that exemplify Keynes' comment about "madmen in authority, who hear voices in the air".

The Labor governments of Australia's states and territories commissioned the Garnaut Climate Change Review in April 2007. The newly elected federal Labor government took over the Review in November 2007. Its Terms of Reference required the Review to assess "The likely effect of human induced climate change on Australia's economy, environment, and water resources …", and to "recommend medium to long-term policy options for Australia … which, taking the costs and benefits of domestic and international policies on climate change into account, will produce the best possible outcomes for Australia". Given this provenance, the Review's *Final Report* (2008) is above all a political document.

The *Report* runs to 634 pages and 24 chapters, rambling over a very wide range of topics, from the science of climate change to the economics of mitigation to prevent change. Clearly it is not possible here to do justice to the whole *Report*. Instead the focus will be on its unsound economics whereby benefits of avoiding future climate change are exaggerated and costs of avoidance minimized. The centerpiece of the *Report's* mitigation proposals is its Emissions Trading Scheme (ETS), yet this receives only a cursory treatment that fails to grasp its likely disruption of the Australian economy.

The *Report* makes many dire projections for the future, including the claim that without drastic reductions in greenhouse gas emissions, chiefly CO_2, there will by 2100 be major declines in gross domestic product (GDP) across the globe, and that in Australia its iconic tourist attractions such as the Great Barrier Reef and the Kakadu National Park will be utterly destroyed by ocean acidification and rising sea levels, while endemic droughts will eviscerate the Murray-Darling Basin. For Australia the *Draft Report* projected "the median temperature and rainfall outcomes for Australia from climate change with unmitigated growth in global emissions [that] may see GDP fall from the reference case by around 4.8 percent, household consumption by 5.4 percent and real wages by 7.8 percent by 2100" (p.17).

The *Report* offers no evidence for such effects having already become apparent despite the warming temperatures experienced globally and in Australia since 1976. On the contrary, that whole period has seen the fastest economic growth ever recorded across almost the whole globe, and Australia is no exception. The last decade of the 20th century was the hottest on record, but it also delivered Australia's longest known sequence of per capita GDP growth above 2.5 percent p.a. (Dowrick, 2001:Table 1.2).

Targets and Trajectories

The *Report's* main thrust is to propose "targets and trajectories" for Australia to lead the World in mitigating the alleged anthropogenic cause of "dangerous" climate change, namely emissions of greenhouse gases, especially CO_2, but also methane (CH_4) and other trace gases, whose global warming potential including that of CO_2 is summed in the combined term CO_2-e (the CO_2-equivalent volume of all greenhouse gases in terms of their alleged warming potential). However these targets are based on false assumptions concerning the current and future absorption of CO_2 emissions by the biosphere and would have more prospect of being adopted by the rest of the world if less onerous.

The Review's earlier *Supplementary Report* tacitly accepted this – "the optimal level of Australian mitigation effort – the level that maximized the income and wealth of Australians – is easily calculated. It would be zero" (2008b:21). Nevertheless, the *Report* adds "while maintaining its support for the 450 ppm CO_2-e objective, the Commonwealth Government should make it clear that it is prepared to play its full proportionate part in an effective international agreement to hold greenhouse gas concentrations to 550 ppm CO_2-e. This would involve reducing emissions entitlements by 10 per cent [of] 2000 levels by 2020, and by 80

per cent by 2050" (2008c:Introduction). Note the absence of any reference to the average absorption of 57 percent of emissions by the biosphere – yet it might help Australia to achieve the international support it seeks for such targets if it explained to its partners that assuming the airborne fraction of emissions remains at about its average 43 percent level over the 50 years from 1958, emissions need only fall to 43 percent of not merely the current but also the ongoing level, not 20 or 10 percent of the 2000 level.

The *Report's* Fig.4.4 depicts "ambitious" mitigation (immediate reduction in emissions) achieving a return to today's 450ppm CO_2-e if only "early in the 22nd century" and "strong" mitigation (fossil and hydrocarbon fuel emissions falling fast enough to stop [CO_2] rising by 2060) achieving reduction just to 550 ppm CO_2-e by 2100. Such targets are aimed at limiting the rise in global mean temperature to not more than 2°C above what it was in 1900. As Richard Tol comments, "this target is supported by rather thin arguments, based on inadequate methods, sloppy reasoning, and selective reasoning from a very narrow set of studies" (2007). It would seem that neither ambitious nor strong mitigation would attain Hansen's 350ppm target for [CO_2] much within 100 years, but that is because biospheric absorption is largely ignored in all these projections.

The less ambitious target reflects the *Review's* pessimistic assessment of prospects of securing agreement by both developed and developing countries to stringent emission reductions needed to keep the world at its present level of CO_2-e emissions of 455 ppm rather than the 550 ppm claimed likely to result from "business as usual" (BAU) by 2030. Offsetting that is the *Report's* optimism that by 2020, technology will be "commercially" (presumably this means not needing subsidies) available to sequester at least 90 percent of the emissions of Australia's – and the rest of the world's – coal-fired power stations. This optimism is despite the Garnaut Review's probably conservative assumption that it will require "a cost of A$250 per tonne of CO_2 to take greenhouse gases from the atmosphere, for recycling or permanent sequestration" (*Supplementary Report*:25). That is well above both the current price in the EU's trading scheme of around A$46 and the recommended transitional price in the *Report* (p.350) of A$20 per tonne in 2010 (to be raised by 4 percent p.a. plus increase in CPI), which means that the price of ETS permits will not be sufficient to encourage adoption of this as yet unproven technology (for the required scale).

Equalizing global per person emissions…

The *Report* makes an interesting contribution with its scheme for developing economies like those of China and India to share the burden of meeting emission reduction target with the developed economies, such that by 2050 emissions will have been equalized across the globe on a per capita basis. Given a 2050 target of stabilization of [CO_2] at 550 ppm, that requires global emissions of CO_2-e to be 30 $GtCO_2$-e (i.e. 8.2 GtC), or 3.0 tonnes of CO_2-e (0.82 tC) per capita of the world's total population, including China and India (2008c: 208). But if the *Report* is right in its assumption (p. 486) that by 2030 there will be technology that makes "clean" energy available "commercially", i.e. at no extra cost above the current costs of "dirty" power and fuels, then presumably there would be no need for equalizing per capita carbon emissions, or for an ETS.

… Does not equalize global per person incomes

The other main flaw in the *Review's* assumption that a target of equal per capita emissions for all countries by 2050 will be acceptable to countries like China and India at the 2009 Copenhagen Conference, is that it leaves per capita incomes in those countries far below what they might be in the absence of keeping their emissions to the targeted level. In fact, in a Figure prepared for the *Review,* but absent from it, it is apparent that per capita incomes in China, and India even more so, not to mention almost all other developing countries, would with equal per capita emission reductions by 2050 be less than half the levels in Australia, the EU, and the USA, despite the latter's emission reductions. Realistically, equal per capita emissions in the absence of equal per capita incomes is unlikely to be a sufficient rallying call

at Copenhagen, and the *Review's* omission of the relevant graph will fool nobody in Beijing or New Delhi.

Science and the Garnaut Report

The *Report's* summary of climate science (in its Chapter 2) begins by stating that "on the balance of probabilities", the consensus view of that science presented by the four successive Assessment Reports of the International Panel on Climate Change (IPCC) is correct. If this comment refers only to the potential impact of increased atmospheric concentrations of greenhouse gases on global temperature it is of course plausible. But if it refers to the consequences of that impact on human well being, the *Report* is seriously at fault. There is no *science* demonstrating that the mid-point of the standard IPCC projection of a warming of 3^oC if CO_2-e doubles from the 1750 level of 280ppm will have any adverse impacts, if only because there is as yet no unambiguous empirical evidence of any such adverse impacts attributable to the rise in the atmospheric concentration from 280 ppm in 1750 to 455ppm CO_2-e in 2005. On the contrary the rise in CO_2-e since 1750 has been associated with a golden age like no other for the great majority of mankind, and never more obviously so since the present warming set in around 1976. Moreover, one of the last century's most brilliant physicists noted that "the efficiency of the carbon trap is insensitive to the amount of carbon dioxide in the atmosphere: increasing the amount five-fold would scarcely change the trap, in spite of the stories that are currently being circulated by environmentalists" (Hoyle, 1981:130). There is not space here to query other aspects of the *Report's* faith in climate science, see Henderson (2008) for a critical discussion, but there are some apparently unresolved issues arising from that science's conflicting measurements.

Can El Niño and La Niña events be attributed to anthropogenic causes?

All authorities agree that the El Niño Southern Oscillation determines climate across much of the globe and remains a dominant force even on net absorption of atmospheric CO_2, (hereafter [CO_2]), see my Fig.1. Yet the standard view that the very hot weather and droughts of 1998, a very strong El Niño year, were due to anthropogenic CO_2 has become difficult to sustain in the light of further growth in [CO_2] since 1998 and no greater frequency or intensity of major El Niño events. Nicholls, an IPCC lead author, conceded (2000, Fig.2) there is no evidence for either eventuality. Moreover, the IPCC's Chapter 9 that he co-authored (in Solomon *et al*. 2007) admitted that their computer models "achieved no consensus", with some showing more frequency and intensity, others less of both, and yet others no change. However while the *Draft Report* (Fig.5.8) claimed that rising global temperature above 3^oC will increase the intensity of El Niño (citing Lenton *et al*. 2008), the *Final Report* also admits "there is no consensus among models as to how climate change will affect the El Niño" (2008c:113) whilst still citing Lenton 2008, although they admit they had no evidence for any tipping point that would increase or intensify El Niño events, make no reference to Nicholls (2000), and rely instead on "aggregation of [their] opinions at a workshop" (see their Table 1). The IPCC admits "whether observed changes in ENSO behaviour are physically linked to global climate change is a research question of great importance" (i.e. unsettled, Solomon *et al.* 2007:288). The *Report* provides a misleading account of both IPCC (2007) and Lenton *et al.* by citing models and "opinions" as if they were evidence.

Defining optimal [CO_2]

The *Report* like the IPCC (2007) provides no *scientific* assessment of what would constitute the optimal level of [CO_2] for the world's ecology and economy. James Hansen argues the world should aim for a level of no more than 350 ppm [CO_2], the level in 1987-1988, and that a level above 450 ppm would be "dangerous" (2008; 2007: 2287), but like the *Report* provides no evidence to show what should be already apparent sub-optimal effects of the rise to 384 ppm of CO_2 by 2007, or 455ppm CO_2-e by 2005. The *Report* claims "the cooling effects of aerosols and land-use changes … reduce the concentration to a range of 311 to 435 ppm CO_2-e with a central estimate of about 375ppm CO_2-e" (38). Aerosols (airborne particles of ash and soot and the like contained in fossil and other hydrocarbon fuel emissions) are unmeasured but

surface as a *deus ex machina* to explain away whatever deviation any model shows from observations of past climate, while "land-use change" is cited by all other authorities, notably the IPCC's Denham *et al.* 2007, Table 7.1 and Canadell *et al.* 2007, Table 1, as a source of warming emissions, not a cooling sink. Note that unlike [CO_2] and the other non-CO_2 greenhouse gases, which are measured and reported monthly from Mauna Loa in the case of [CO_2], and annually by the NOAA in the case of CH_4 and other non-CO_2 gases, the radiative forcing effect of all these gases is not measured but flows only from various assumptions, including especially their duration in the atmosphere, which is neither measured nor measurable. For example, there appears to be no consensus on the CO_2 equivalent radiative forcing of CH_4, which ranges from 21 times larger to 72 (Brook *et al.* 2008:5).

Measurement and Climate Change

There are some other serious differences in the measurement of key climate change variables. Real science involves precise measurement, so it is disconcerting to find wide variations in climate scientists' measurement of the proportion of hydrocarbon fuel emissions that remains in the atmosphere (known as the Airborne Fraction, AF). Hansen and Sato (2004) stated the AF averaged 60 percent, Hansen *et al* 2008 show 57 per cent, while Canadell *et al.* (2007:18867) find it was 43 percent from 1958 to 2006. There is no doubt Hansen and co-authors have miscalculated the AF, as evident from the raw data in my Table 1 (online) (also available at www.carbonproject.org). The latter source shows total uptakes were 1.84 GtC in 1958-59, or 48 percent of total anthropogenic CO_2 emissions of 3.87 GtC, for an AF of 52 percent. In 2007 uptakes were 53 percent of emissions of 9.94 GtC, and the AF (or increase in [CO2]) was therefore 47 percent of emissions (there are 3.67 tonnes of CO_2 per tonne of carbon, and 2.12 GtC per 1.0 ppm of [CO_2]).

Similarly, there is no agreement on the relative contributions of net oceanic and terrestrial absorption of [CO_2]. Canadell *et al.* show on average equality between 1959 and 2006, but with the terrestrial growing more rapidly so that by 2000-2006 it absorbs 2.8 GtC as against 2.2 GtC by the oceans (2007: Table 1). The *Report* shows the oceans *always* absorbing more than the land (Fig.2.7). Such discrepancies between the "scientific" measurements of the IPCC and the *Report* ought to be worrisome, in the light of the drastic policy changes proposed by the latter.

Divergent projections of [CO_2]

Similarly, using the IPCC's compound rate for [CO_2] growth since 1958 of 0.4 percent p.a., it will take until 2178 for the 2007 level to double, while the *Report* manages to project a surprising 1000ppm for [CO_2] and 1565ppm for CO_2-e by 2100 for the no-mitigation (BAU) level (2008c:86). It achieves this by projecting gross emissions at the current unusually high rate of over 3 percent p.a., ignoring the minimal measured growth of atmospheric CH_4 since 1990 and downplaying the absorption that restricts the [CO_2] growth rate. Thus in line with Wigley *et al.* (2008), the *Report's* projections raise the growth rate of [CO2] to 1.0 percent p.a., and imply a growth rate for the atmospheric concentration of CO_2-e of 1.13 percent p.a. from 2000, more than double the IPCC's observed rate of 0.5 percent p.a. in 1998-2005 (Solomon *et al.* 2007: 141). These projections derive from Enting *et al.* (2008) and their use of Wigley's C4MIP group of models, which treat oceanic and terrestrial absorption as merely a residual of modelled CO_2 concentration trajectories and associated [CO_2]. The paper by Friedlingstein *et al.* (cited by both Stern and Garnaut) also relies only on models (2006: Table 3), and ignores data in Long *et al.* 2006 and Norby and Luo 2004 showing that temperatures would have to rise by at least 15°C above the present for the [CO_2] fertilization effect at 650ppm to be reversed. Norby and Luo comment that models (like C4MIP) that are not "adequately evaluated against real data [are] almost useless".

Water Vapour as a Greenhouse Gas

A similar error is the *Final Report's* claim (2008c:29) of the "dominant influence" of carbon dioxide as a greenhouse gas, omitting the more significant role of water vapour, which is

about double in volume. Its discussion of water vapour shows unawareness that hydrocarbon fuel emissions may contain as much water as CO_2 – in the case of Victoria's brown coal power stations, their emissions contain as much as ***five*** times more water vapour than CO_2 – but claims "humans have a limited ability to directly influence its concentration". This is curious when hydrocarbon fuel emissions comprise both water and CO_2, and the *Report* argues we can and will achieve emission reductions. It is of course true that evaporation from the oceans is larger than from the land, and is therefore the main source of precipitation everywhere. However, as atmospheric water vapour has a residence time of no more than 10 days before descending as precipitation (IPCC, Penner *et al.* 1999:33), most hydrocarbon fuel burning in Australia is likely to produce precipitation falling as rain in this country. For example, 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 (Penner *et al.,* 1999:33). Moreover, "climate models and satellite observations both indicate that the total amount of water in the atmosphere will increase at a rate of 7 percent per kelvin of surface warming. However, the climate models predict that global precipitation will increase at a much slower rate of 1 to 3 percent per kelvin. A recent analysis of satellite observations does not support this prediction of a muted response of precipitation to global warming. Rather, the observations suggest that precipitation and total atmospheric water have increased at about the same rate over the past two decades" (Wentz *et al.,* 2007). Yet the *Report* persists in attributing Australia's drought cycles to rising [CO_2] (108).

The Carbon Budget

The rarely displayed Carbon Budget data in my Table 1 show the relationship between total emissions of CO_2 from both hydrocarbon fuel burning and land-use change and biospheric uptakes, on one hand, and, on the other, the resulting yearly change in [CO_2] (stated in GtC). Once known as the "missing sink", the uptakes (U) are always the residual between the known year-on-year data on [CO_2] (C) and the less well-attested annual total of CO_2 emissions (E).

The accounting identity is:

$$C_t - C_o = E_t - U_t \quad ...(1)$$
$$U_t = Et - (C_t - C_o) \quad ...(2)$$

Equation (2) can be misleading, as it implies that CO_2 absorption (U) is merely a residual when it is an independent if so far unmeasurable process, and in reality it is C, i.e. [CO_2], in (1) that is the residual or dump. The Oceanic component of the Uptakes has been estimated but with wide variations, and in such models (e.g. Wigley 1993, Table 2) the Terrestrial component becomes the residual. Unfortunately, most modelling uses the procedure in Wigley (1993) for future Uptakes, which means they have no independent existence and are implied only by whatever the models project for emissions and concentrations, as in the *Report* itself. Nonetheless, the Uptakes are *independent* variables, unlike [CO_2], but are *never* treated as such in the models described by the IPCC's Randall and Wood *et al.* 2007.

Instead, the *Report* claims "it is generally accepted that future climate change will reduce the absorptive capacity of the carbon cycle so that a larger fraction of emissions remain in the atmosphere compared to current levels (IPCC 2007: 750)" (p.36), yet such absorption has increased almost exactly *pro rata* with emissions (Table 1). Canadell *et al.* 2007 show that the total biospheric uptake increased from 2.1 GtC in the 1980s to 3.1 GtC in the 1990s, and averaged 5 GtC from 2000 to 2006). "General acceptance" is nothing better than conventional wisdom in the absence of evidence, of which there is none either in the *Report* itself or in Randall and Wood *et al.*

Natural Absorption of Carbon Dioxide

The *Report* admits (65) "almost 45 per cent of human emissions since 1750 have remained in the atmosphere", so that more than 55 percent have not. The *Report* adds: "in general, higher atmospheric concentrations of greenhouse gases, and the resulting changes to the climate system, reduce the absorptive capacity of the carbon cycle so that a larger fraction of

emissions remain in the atmosphere compared to current levels (IPCC 2007a: 750). Examples of climate–carbon feedbacks include the decrease in the ability of the oceans to remove carbon dioxide from the atmosphere with increasing water temperature, reduced circulation and increased acidity (IPCC 2007: 531); and the weakening of the uptake of carbon in terrestrial sinks due to vegetation dieback and reduced growth from reduced water availability, increased soil respiration at higher temperatures and increased fire occurrence (IPCC 2007: 527; Canadell *et al.* 2007)". The three citations of the IPCC show no evidence for these claimed effects, while Canadell *et al.* 2007 rely on a dubious claim that the relative rate of growth of biospheric absorption is slowing (see below).

The *Report* concedes that "to achieve stabilisation of carbon dioxide concentrations, emissions must be brought down to the rate of natural removal" (43), but adds "the rate of absorption of carbon by sinks depends on the carbon imbalance between the atmosphere, the oceans and the land, and the amount already contained in these sinks. [1]

Once stabilization in the atmosphere is reached, the rate of uptake will decline (Figure 2.7). Long-term maintenance of a stable carbon dioxide concentration will then involve the *complete elimination* of carbon dioxide emissions as the net movement of carbon dioxide to the oceans gradually declines" (IPCC 2007: 824; Enting *et al.* 2008, my italics). The *Report* does not mention "natural removal" averaged 57 percent from 1959 to 2006 (Canadell *et al.* 2007: Table 1), nor does it discuss the impact on the biosphere of zero net additions to the amount of CO_2 in the atmosphere. Implicitly, it assumes preventing any further growth of [CO_2] will not impact on the current large absorption and thence on still growing global populations of plant and animal life when emissions virtually cease around 2050 (if the *Report's* "complete elimination" of emissions is adopted).

Saturation of [CO_2] Sinks?

The *Report* refers to IPCC models' predictions of declining sinks, based on the unproved assertion that these result from rising temperature. In reality, photosynthesis increases as temperature rises to an optimum and decreases with further warming, but "at any given temperature, photosynthesis increases with increasing CO_2", and the optimum temperature also increases (Norby and Luo 2004: 283). That is why observations show "little change" in the ocean sink's absorption at 2.2 GtC p.a. while the land sink averaged 2.0 GtC p.a. in 1970 to 1999 and 2.8 in 2000 to 2006 (Canadell *et al.* 2007: Table 1).

The Garnaut Review's Enting *et al.* (2008) say the alleged "feedback process" from rising temperature to declining sinks is not included "in the present modelling, because the carbon components of simple climate models are tuned to match 20th century changes in CO_2". They appear to be arguing that positive feedbacks such as ocean warming leading to less absorption are not explicitly captured in carbon cycle modelling, but should be captured implicitly because the models have been "tuned" to the outcomes of all past sink processes as expressed in the record of concentrations, and that even if sinks have increased, this does not preclude the possibility that this increase may be limited and later reversed by increasing temperature. That is possible but is so far an implausible assumption, especially for the terrestrial sink. Vast land areas remain uncultivated and while [CO2] and other inputs remain available, they can hardly be deemed a "saturated" sink.[2]

Such unsupported assumptions underlie much of the alarmism of the *Report* and its call for elimination of nearly all emissions by 2050. The claim that all global biospheric uptakes of carbon, both through oceanic and terrestrial photosynthesis and also by oceanic absorption, will be declining by 2050 if not before, because the oceanic and terrestrial sinks will become totally "saturated", derives from Canadell *et al.* 2007 (Table 1, cited by the *Report,* 2008:37) and from the book edited by Canadell *et al.* (2006) which claims that absent immediate action to reduce emissions of CO_2, there will by 2100 be "no further carbon dioxide removed from the atmosphere". Since without such removal being possible, all animal and human life will

cease, these authors herald a new Doomsday like that in Stanley Kubrick's movie *Dr. Strangelove, or How I learned to stop worrying and love the Bomb*.

This assumption of disappearing biospheric absorption of the gross emissions of CO_2 from hydrocarbon fuel burning and land use change implies they will all eventually remain in the atmosphere, i.e. the AF will become 100 percent of emissions. This leads to the *Report's* claims of increasing [CO_2] producing accelerated global warming under BAU. There is as yet no evidence for such imminent saturation of all sinks. The latest annual data on the level of [CO_2] at Mauna Loa (December 2007) shows that it still increased by much less, at 4.34 billion tonnes of carbon (GtC), than the additional CO_2 emissions since December 2006 of 10.22 GtC, which as noted above means the "saturated sinks" absorbed 5.78 GtC.

Thus the *Report* proceeds on the basis that given the projections of gross CO_2 emissions in Garnaut *et al.* (2008), global emissions need to be reduced *to* 40 percent of the 2000 level of 8.39 GtC, i.e. to 3.36 GtC, if the world is to avoid future "dangerous" climatic change. Yet, if emissions are reduced only to the level of the natural uptake, this allows emissions to have been 5.78 GtC in 2007 (the actual uptake that year), or as much as 72 percent higher than the target prescribed to the *Report* by its commissioning government. Aiming to reduce emissions just to the natural uptake level results in *zero net emissions*, and hence, *cet.par,* zero net increase in [CO_2]. Enting *et al.* (2008) to some extent recognized this, unlike the *Review*: "Thus our range of emissions to balance natural uptake is 1.5 to 2.5 GtC/yr in 2200 (depending on concentration target and chosen pathway)" (2008:41), but they provided no evidence to support their claim that by 2200 uptakes would be far below the 5.78 GtC in 2007.

Carbon Dioxide and the Economy

"The extent to which carbon fertilization could alleviate any adverse effects of global warming on agriculture has been a central issue in analysis of the severity of these effects" (Cline 2007:23). There is a large literature (e.g. Long *et al.* 2006, Tubiello *et al.* 2007, Ainsworth and Farquhar *et al*. 2008) demonstrating the increased yields both in greenhouses and in "free air carbon enrichment" (FACE) experiments when CO_2 levels are raised. None of these show the impact of *permanently* enhanced [CO_2]. Nevertheless, Cline estimates the "weighted average increment in yield from carbon fertilization would be 9 percent at 550 ppm… and 15 percent at 735 ppm" (2007:25).

The eminent physicist Freeman Dyson recently noted (2007) "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. If the air were not constantly stirred by convection currents and winds, the corn would stop growing."

Yet the *Report,* like the *Stern Review* (2007) and the Australian Government's *Green Paper: Carbon Pollution Reduction Scheme* ("CPRS", 2008), downplays CO_2 fertilization and offers no basis for supposing that world agriculture, forestry, and fisheries would sustain today's volume of production at the 350 ppm level, even less so at the usual depiction of the pre-industrial 1750 level of 280 ppm as being both the optimal and the equilibrium level. Neither the *Report* nor the *Green Paper* discuss the impact of reducing emissions almost to zero on primary production dependent on photosynthesis making use of [CO_2]. Yet authors like Lloyd and Farquhar (2008) find "the magnitude and pattern of increases in forest dynamics across Amazonia observed over the last few decades are consistent with a CO_2-induced stimulation of tree growth".

Wheat Yields and Elevated [CO_2]

The *Report* (131) describes the analysis by its commissioned paper (Crimp *et al.* 2008) showing strong correlations between elevated [CO_2] and Australian wheat yields. In each of ten locations covered by the study, yields are higher in 2030 under the no-mitigation 550ppm than under either of the with-mitigation 450ppm and 550ppm scenarios, while in three locations yields are still higher in 2100 (despite alleged higher temperatures and lower rainfall without mitigation) than with mitigation reducing the atmospheric concentration to 450ppm CO_2-e. These results confirm the findings from historic data (1959-1999) of the dominant role of increasing [CO_2] in raising wheat yields across many wheat growing areas in New South Wales and the USA (Curtin and Smart 2009).

This means it would be rational for wheat farmers alive now to vote against application of the ETS to them (promised by 2015) and for those farming in 2030 to review the situation then. It is curious the *Review's* study shows benefits of increasing [CO_2] for a major sector of the Australian economy that the rest of the *Report* is at pains to deny, whilst at the same time implying that *reducing* [CO_2] would have no negative effects on agricultural and livestock output. Yet that could have disastrous consequences for all primary production, including livestock. Data in Cline (2007:90) indicate the global cost would be as much as $US5 trillion a year by 2080 at October 2008 wheat prices. Similar effects are apparent in Tubiello *et al.* (2007) and Ainsworth *et al.* (2008:1318). The latter note there has so far been no attempt to breed for enhanced [CO_2] responsiveness, which means that the Crimp and Cline estimates are probably understated.

Since it is these biospheric absorptions that have supported the growth in world food production, what will happen to that if emissions are reduced below them? Regression analysis of world food production against [CO_2], temperature, fertilizer use, and population growth shows that the only significant variable is [CO_2] (with the exceptionally high R^2 of 0.98, Curtin and Smart 2009). The emission reduction programme of the *Report* and the *Green Paper* has the capacity to reverse world food production increases of the last three decades, producing real hardship even starvation for those unable to absorb higher food prices.

Eat Kangaroos, not beef or lamb

The *Report* attracted particular media attention for its proposal, that because of the alleged much greater global warming potential of emissions of methane from livestock than from any other sector of the Australian economy, this sector should be included in the ETS as soon as possible.[3] However, this allegation depends on the IPCC's standard claims that emissions arise from nothing, in this case that supposedly livestock never eat anything containing carbon. But the FAO (in *Livestock's Long Shadow,* 2006:Table 3.2) shows that while 110 GtC are transferred from atmosphere to earth by photosynthesis, 50 GtC are emitted back to atmosphere by respiration from plants and animals, and just 2 GtC by deforestation. Although the FAO report does not provide data on consumption of carbon by livestock, and only when we have data on this can we begin the blame game, it does describe the world's livestock as a net sink of [CO_2] and [CH_4] (2006:95). Moreover its Tables 3.6 and 3.7 show that total livestock emissions of CO_2 are 3.16 GtC p.a., and of CH_4 85.6 million tonnes, for a ratio of CO_2:CH_4 of 37:1. This may well explain the determination of Brook-Singer-Russell in their influential Submission (2008) to the Garnaut Review to raise the IPCC's global warming potential ratio for CH_4:CO_2 from 21:1 to 72:1, an assertion yet to appear in a peer-reviewed paper but accepted by the *Report*. Cutting CO_2 emissions will reduce pasture yields and livestock productivity, supporting the *Report's* planned excision of this sector by including it in the ETS.

The Emissions Trading Scheme

Before the Kyoto Protocol (1997) it was unknown for countries to impose sanctions on their own economies. Just as the science of the IPCC smacks of Lysenkoism (Evans 2008), for it is hardly a coincidence that the "Green" NGO proselytizers on behalf of the IPCC are like Lysenko in his time, opposed to genetically modified (GM) crops, so also an ETS marks an

emulation of the self-flagellation practiced by medieval ascetics to promote their claims for eventual canonization. The *Final Report's* ETS is somewhat softened from that in the *Draft Report*, with provisions for full auctioning of permits only after a two-year transitional period to 2012 during which permit prices will be fixed at $20 per tonne of CO_2 but increasing at 4 percent p.a. plus inflation. But it maintains a hard line against the kind of exemptions for emissions-intensive trade-exposed (EITE) industries proposed in the Australian Government's *Carbon Pollution Reduction Scheme (CPRS)* (2008), arguing instead that such industries should receive credits only against their permit obligations equivalent to the increase in their overseas competitors' prices that would eventuate if they faced a similar ETS (2008c:114). Either way, complete or partial exemptions must raise permit prices faced by, and emission reduction targets imposed on, non-trade exposed industries (if any).

Although the *Report's* ETS was overtaken by the rather different structure, put forward less than two weeks after it first appeared, by the *CPRS,* both versions have already earned a good deal of criticism, most notably in a report commissioned by the Business Council of Australia (Port Jackson Partners Ltd 2008). Its study of a sample of 14 leading EITE firms subject to the *CPRS'* ETS showed that their median profit reduction would be over 50 percent, while three would be out of business by 2020 and another four would have their earnings before interest and tax (EBIT) reduced by half on average, while six of the remaining seven would have to reduce their operating costs by at least 10 percent. This report expects most of these firms to relocate overseas unless the ETS is adopted worldwide.

The similar study commissioned by the Australian Conservation Foundation (Innovest, 2008) shows that in the absence of the Green Paper's EITE compensation scheme, Australia's alumina and aluminium industries would incur extra costs of over A$1 billion by 2010, at a CO_2-e price of A$20 per tonne, and double that at the EU's present ETS price. The *Report* with its rejection of compensation blithely expects this industry to relocate to Kinshasa or elsewhere with hydropower. The Innovest study (2008:Table 1) expects that the livestock industry would incur ETS costs of over A$300,000 per A$1 million of sales revenue at the current EU ETS price of A$45 per tonne of CO_2-e, equal to a profits tax of 100 percent if the profit margin is as high as 30 percent (not likely!), and certainly bringing about its demise as recommended by the *Review*. The equivalent figure for the cement industry is 21 percent of gross revenue, for sheep and dairy cows around 15 percent, and for black coal and iron and steel over 7 percent. Equating the ETS to a tax on profits, its effective tax rate ranges from 23 percent, for the last named, to 110 percent *over and above* the basic corporate tax rate of 30 percent. If this is not a recipe for wiping out most if not all Australian primary and manufacturing industry, all of it being EITE, it is difficult to imagine what would do it any better. Even the financial and services sector would survive only at a reduced level, given they would have lost so many of their prime clients to bankruptcy or relocation overseas. In partial recognition of this the Government has flagged that its December 2008 White Paper will extend compensation and allocation of free permits to selected industries

ETS Auctions should be based on Marginal not Total Emissions

Some of this criticism would have been avoided if the Garnaut *Report* and the *Green Paper* had considered the option of auctioning permits only for emissions in excess of the reduction schedule. Instead they insisted on auctions for every tonne of carbon emissions. For example, if in 2010 (first year of the ETS), the schedule established a cap of 99 percent of emissions in 2008, the CPRS implies (for all except industries considered to be EITE) that permits would have to be acquired for 99 per cent of previous-year emissions. This is what led to the dire results for most of the industries analyzed by the BCA, because of the massive impact on their cash flows, which as they are all at least partly trade exposed, means they would not be able to pass on all respective auction costs to their overseas or domestic customers. A better option would have been to restrict the auction to permits for emissions only in excess of the annual cap, which is broadly the basis of the EU's ETS. As economists other than those involved in the *Review* and CPRS understand, it is costs at the margin that determine investment

decisions. Thus it is only necessary to auction permits for emissions above the cap, not for all emissions 99 percent of which will be allowable by the initial cap (Curtin 2008b). Having to pay for permission to emit within the cap seems redundant – it is as if drivers were to be fined for driving below the speed limit as well as above it – but will have serious implications for affected firms' balance sheets, especially the EITE.

Restricting emission reductions to the rich

The *Green Paper's* acceptance in principle, apart from temporary exemptions, of the *Report's* auctioning of permits per tonne of all emissions, confirms suspicions that a major motivation in the whole exercise is the prospective large income transfers from rich to poor that will arise from the handling of the huge proceeds of the auctions of emission permits. For it is clearly intended the total burden of emission reduction will fall on the rich while the lower middle classes and the poor will be enabled to consume as much fuel and electricity, in real terms, as before.[4]

The *Report* proposes the "poor" would receive at least half of annual total receipts of the sale of emission permits. These could well amount to $16 billion (at $40 per tonne of CO_2, with Australia's non-agricultural emissions being over 400,000 tonnes), rising over time as the falling caps raise the auction price of permits, but poor households could expect to receive around $8 billion in the first year of the auctions. Assuming that 50 per cent of households have income of less than $53,000 (the government's means test cut-off), then around 3 million households would qualify for handouts worth over $2,000 p.a., comfortably enough to cover their total annual spending on electricity and with enough left over to cover most of their higher petrol costs, at $468 p.a. if petrol rises from $1.70 a litre to $2, assuming annual consumption of 1,560 litres (if the emissions charge is fully passed on by Caltex *et al.*) The CPRS similarly proposes the cut-off between "poor" and "non-poor" will be $53,000, and that it is the latter who will not only have to pay the *total* costs of mitigation, but also be expected to reduce their emissions by more than the overall target in order to offset the ongoing emissions of those protected by compensation from having to reduce their emissions.

Compensating payments to the poor will maintain their CO_2 emissions

While it is true in the case of "normal" goods that consumption rises with income, both electricity and petrol are Giffen ("inferior") goods in countries like Australia, in the sense that with fixed prices, their proportion of household budgets falls as income rises (ABS, 2001:255). This means when government compensates lower income households for higher domestic energy prices with cash transfers at least equal to their pre-ETS spending on it, they tend to maintain their previous level of consumption (Chiang, 1984:408). The *Green Paper's* rejection of the *Review's* proposal to put the proceeds of auctions into a Carbon Bank, suggests it is plausible the attraction of full auctioning of permits is that it will create a large slush fund for buying of votes in marginal suburban constituencies.

Discount rates and cost benefit analysis of climate change

The *Report's* discussion of the choice of discount rates for assessing the costs and benefits of climate mitigation, when as ever the costs are upfront and the benefits if any only accrue down the track, perhaps not for 100 years, follows the *Stern Review's* approach (2007). That means ignoring that the primary purpose of the discount rate is to measure any project's net benefit against the opportunity cost of the funds used to finance the project (Byatt, 2008:92). It makes no sense to argue like the *Report* that since at a real discount rate of 4 percent, a dollar in 50 years' time is worth just 13 cents today (or just 36 cents at the usual real rate on US Treasuries of 2 percent), we should not use such market rates, since to do so would mean we "are comfortable about living for [our] moment" instead of that of future generations (43-44).

This motherhood statement ignores that the benchmark discount rate for most industries and enterprises listed on the stock exchange is usually around 15 percent nominal, or about 11 percent in real terms. Even for prime borrowers the present cost of funds in Australia is of the

order of 9-11 percent (which was the range of effective yields on floating rate bonds issued by Adelaide Bank, Macquarie Group, NAB, Suncorp Metway, and Woolworths as of 7th July 2008, *Australian Financial Review*, 8th July 2008).

What the *Report* would have us believe is that these enterprises would consider it beneficial for their shareholders if they borrowed at around 10 percent p.a. now either to finance their purchases of emission permits, or to undertake emission reduction programmes, which only show a return (in terms of avoided costs of climate change for present shareholders if they live to 2100) if the discount rate is close to zero. But such benefits if they ever accrue in no way recoup *present* financing costs. It is incontestable that if today's firms like the above invest in projects returning more than the current cost of commercial paper over the normal project horizon of 30 years, they will in 2038 be in a much better position to invest in whatever climate *adaptation* projects might then show a reasonable prospective return, without resort to near-zero discount rates - and *a fortiori*, likewise in 2068.

It is indeed unethical to impose an ETS regime based on a subjective near-zero discount rate to "yield" benefits in 2050-2100 possibly larger than costs from 2010-2050 whilst failing to offer financing at that discount rate to firms required to purchase ETS permits from 2010. The present Australian government has effectively done this to support the country's banking system during the 2008 financial crisis, with its largely free guarantees of all deposits, so there appears to be no reason why it could not do as much to support its ETS by providing interest-free loans for firms required to purchase emissions permits.

More generally, the Report's use of a very low discount rate to compare costs incurred by today's generation with benefits (if any) that accrue only to future generations overlooks economists' main criterion for determining the equity of a proposed policy change, the Pareto rule that gainers from a new policy should benefit enough to be able in principle to compensate losers. Obviously that will not be possible as the present generation will almost all be dead by 2100. That is a good reason for delaying introducing climate mitigation policy until either gainers are able in principle to compensate losers, or all costs are outweighed contemporaneously by gains to all. The *Review* argues against this by claiming speciously that the costs will be more in future that they are now - but it is more likely that better and cheaper technology for emission- free power generation will be available by say 2070 than by 2010 or 2020.

The Prisoners' Dilemma

The *Report* is again at fault when it describes the task of securing global commitments to greenhouse gas emissions reduction as the Prisoners' Dilemma, when what the *Report* should address is the "Tragedy of the Commons". The Prisoners' Dilemma involves two prisoners accused of a crime that they did commit. Let us name these villains as Australia (A) and China (C), guilty of the same crime, the one being the world's biggest per capita carbon emitter, and the other the world's largest total emitter. Their jailer in the original game offers both a plea bargain, whereby if each implicates the other, he will escape prosecution or secure a light penalty. The dilemma is that neither knows what the other has been offered or whether he will accept the plea bargain. The best course would be for A to accuse C if he could be sure C did not reciprocate, but if both remain silent they will escape prosecution altogether. Since neither A nor C is in prison, and there is no world prosecutor to offer plea bargains, it is difficult to see the relevance of this Dilemma in the context of climate change negotiations. China seems so far disinclined to adopt the required selflessness.

The Dilemma is also associated (wrongly) with the free-rider syndrome. Here, using our example, China will be accused of being a free-rider if it fails to sign up to the massive emission cuts likely to be demanded in Kyoto II. But this pre-supposes that there will be any benefits to China if Australia and the rest of the OECD block agree to cut their emissions by 60 percent or more, since China's new emissions every year already exceed the OECD's

planned reductions. It follows that China will enjoy no benefits from the OECD's selflessness, as it will produce no global cooling. Ergo, China (like India) is not a free rider. But even if it were, under the rules of the game, Johansson (1991:69) has shown that indeed, *pace* Stern and Garnaut, "the best strategy for each player is to be a free rider…. the players in the prisoner's dilemma game lack the means to enforce the preferred cooperative outcome".

The more relevant model is the "Tragedy of the Commons", but even that has ambiguity. The world's atmosphere is a Commons, owned by none, and receives all the world's airborne waste products free of charge, including so far those from both Australia and China. Ronald Coase (1990) showed how in a Commons, the best course of action is for A if suffering damage from C's pollution to offer to compensate C for the costs of reducing its pollution. The EU, Australia, and the USA have already shown they do not have enough to gain from avoided climate change costs to be willing jointly or severally to offset the costs to China, India, Brazil, and Thailand, to name only a few, of their adoption of mitigation programmes.

The St Petersburg Paradox

The *Report* shows also only a superficial understanding of the economics of risk and uncertainty. But, "venturesome people place high utility on the small probability of huge gains and low utility on the larger probability of loss. Others place little utility on the probability of gain because their paramount aim is to preserve their capital …think what life would be like if everyone were phobic about lightning, flying in airplanes, or investing in startup companies [or climate change]" (Bernstein 1998:105). The *Report* demands uniformity of view on such risks, and its ETS proposes to tax all, not equally, but in proportion to their incomes, because it accepts Daniel Bernoulli's claim that "utility resulting from any small increase in wealth will be inversely proportionate to the quantity of goods already possessed" (quoted in Bernstein 1998).

That belief underlies the low discount rates used by Stern and Garnaut. But while each successive equal increase in income may – but not always for all – yield less "utility" than the previous, by the same token the marginal disutility yielded by a reduction from any given level will necessarily exceed the positive marginal utility provided by a gain of equal size from that level (Bernstein 1998:112). Garnaut like Stern posits large losses from the putative future costs of "dangerous climate change" against the claimed relatively low present costs of mitigating such change. As Bernoulli saw nearly 300 years ago, this is a two-edged sword. Gains (in this case avoided losses from higher future incomes) will have marginal utility valued less dollar for dollar than losses incurred on this generation's lower incomes - but Garnaut would have us believe that is not the case in regard to the costs and benefits of mitigating climate change. A zero-sum game like an ETS (because emission permits saved and sold exactly equal permits bought) is really a loser's game when it is valued in terms of utility. Bernstein concludes, "the best decision … is to refuse to play this game" (1998:113). "Game" is an apt term for Emissions Trading, and it is indeed best avoided.

CO_2 Emissions confer unrequited benefits as well as costs

The *Report* follows Stern by claiming that emissions of CO_2 produce only social ("external") costs, constituting "the greatest market failure the world has ever seen" (2008c: 307). In reality we all also derive external benefits from CO_2, and owe a debt to the emitters whose output of CO_2 has done so much to enhance global food production and growth of rainforests (Norby and Luo 2006, Lloyd and Farquhar 2008, Crimp *et al.* 2008, Curtin and Smart 2009). Thus the alleged "market failure" must also apply to the huge social benefits of carbon dioxide. Those benefiting from the enhanced crop yields enabled by the growing [CO_2] never reward the CO_2 emitters for this free benefaction. Cline (2007:25,90) provides an estimate of the value of the benefaction if [CO_2] increases to 735 ppm by 2080. *Cet.par.,* his projected increase in yield of 15 percent implies an increase in global production of 250 million tonnes of rice, wheat, maize, and soya, or $US5.5 trillion at October 2008 prices.

Both the *Report* and the *Green Paper* emphasize Australia's high per capita emissions of CO_2, to support their insistence that Australia needs to make a greater effort than the rest of the world to reduce its emissions. Obviously the many authors of the *Green Paper* and the *Report* are unaware that Australia's annual per capita *net* emissions are far from being the world's highest. As we have seen, the *Report* discusses only gross emissions, and not the much smaller increase in [CO_2] that arises after net biospheric uptakes have removed on average 56-57 percent of gross emissions since 1959. Yet in practice Australia despite its alleged endemic droughts is one of the world's largest *per capita* cereal producers, at 2,000 tonnes *per capita* in 2004 (FAO 2006), against a world average of 500 tonnes. All crops absorb carbon through photosynthesis using atmospheric oxygen and CO_2, much of which is taken up by animal or human life, with some of the balance remaining in the soil, and much of the rest eventually respired after being stored in the bodies of the consuming creatures for their lifetimes. Animals and humans use absorbed carbohydrates as energy in the ordinary business of life until death, while exhaling CO_2 and some CH_4. The same stress on gross rather than net effects is evident in claims that the livestock industry produces only emissions of greenhouse gases, without noting that the world's livestock population is itself a store of carbon. The FAO's *Livestock's Long Shadow* makes this very point (2006:95).

CONCLUSION

The Garnaut *Report's* stringent emission reduction targets stand or fall on the validity of the climate science of the IPCC. Apart from the Arrhenius hypothesis that rising [CO_2] levels can have a warming effect, the rest of the IPCC's climate projections derive from models heavily dependent on the unfounded assumptions that biospheric absorption will decline with the higher temperatures arising from elevated [CO_2], thereby further raising [CO_2] and temperature in second round effects, and that all other feedback effects will also be positive for warming. But even if this science proves correct, the *Report's* unsound economic cost-benefit analysis results in policy proposals that impose inordinate costs now for uncertain benefits far in the future. It is much more certain that by 2100 the *Report* will have taken its place alongside Malthus (1799), Jevons (1865), Ehrlich (1970), and the Club of Rome (Meadows *at al.* 1972) for being as spectacularly wrong as these eminent "scribblers" were with their equally fanciful predictions.[5] There is also no likelihood either that the drastic global emission reductions the *Report* seeks will be implemented, or if they are not, that there will then be any of the predicted adverse effects on economic growth. It is far more probable that if the *Report's* emission reduction targets are implemented on a global scale, there may well be unintended consequences in the form of mass starvation, as it offers no evidence for its implicit assumption that the current growth of world food production will continue in the face of the declining atmospheric concentration of CO_2 that it seeks to promote.

Online Supporting Material

Abstract

The Garnaut *Report* sets out targets for reductions of greenhouse gas emissions allegedly responsible for dangerous climate change. Its preferred target is "holding" emissions to just 10 percent of the 2000 level by 2050. This paper shows the *Report's* targets are overstated because its model underestimates the extent of biospheric uptakes of the main greenhouse gas, carbon dioxide, CO_2, and fails to show that the greater are emissions, the larger are those uptakes. The targets are also based on false claims the biosphere is already "saturated" with CO_2. In reality the "Airborne Fraction" of anthropogenic emissions has averaged only 43 percent of total emissions since 1958. Other errors include its treatment of the international agreements needed to secure large reductions in emissions as the free-rider problem of the "Prisoners' Dilemma" and its use of marginal utility theory to justify the low discount rates needed to sanction costly strong action

now, which overlooks the St. Petersburg Paradox. The Emissions Trading Scheme (ETS) proposed by the *Report* is likely to undermine the Australian economy by rendering much of its primary and industrial production unprofitable.

Endnotes

1. Stern (2007:218) like the *Report* accepts that emissions of CO_2-e need only be reduced to the level of "natural absorption", but is both more precise and more wrong: "in the long term global emissions will need to be reduced to less than $5GtCO_2e$, over 80 percent below current annual emissions [$c.25GtCO_2e$]". In fact uptakes of CO_2 alone were already over $18.35GtCO_2$ in 2005 (Canadell *et al.* 2007: Table 1). Stern relied on the modelling by Meinshausen *et al.*2006 which excludes any role for Uptakes.
2. This author provided both the equations of the carbon budget and the data in Table 1 to the Garnaut Climate Change Review, Curtin 2008a, but see Le Quéré 2008. The sinks that absorb [CO_2] are hardly ever specified in the various modelling exercises of the IPCC (Randall and Wood *et al.*) that make use (2007:644) of the MAGICC model (Wigley *et al.* 2002, Wigley 2008). This does not directly enter negative elements in the carbon budget, i.e. the uptakes. Instead they are projected at whatever is the level needed to validate the emission and concentration scenarios of its component models (Wigley 1993: Table 2). Randall and Wood (2007) cite the claim in Friedlingstein *et al.* (2006) "that in all models examined, the sink decreases in the future as the climate warms". The claim by Canadell *et al.* (2007) that the rate of growth of biospheric absorption of CO_2 emissions is slowing relative to the growth of emissions depends heavily on choice of terminal dates. The claim appears valid if the final year is an El Nino year, but not otherwise. Such claims also ignore the observations in Long *et al.* 2006 and Norby and Luo 2004. See also Curtin 2007.
3. For example, *The Australian,* 1st October 2008: "Eat Kangaroo to help combat climate change": "[Garnaut cites researchers who] conclude that by 2020, beef cattle and sheep numbers in the rangelands could be reduced by seven million and 36 million respectively, and that this would create the opportunity for an increase in kangaroo numbers from 34 million today to 240million by 2020". The *Report* did not mention the impact of these reductions on Australia's exports of beef (which account for two-thirds of total production), wool, and sheep.
4. The *Report* advises against cash payments that would enable the non-rich to maintain their present real spending on petrol and electricity, in favour of payments in kind. However the *Green Paper* of 16th July 2008 proposes that compensation will be payable in cash, which it claims "should not blunt the incentive to change behaviours in ways that result in lower emissions" (Summary: 25).
5. The *Report* endorses Jevons who in *The Coal Question* (1865) predicted exhaustion of the UK's coal reserves by the 1920s; so far from being exhausted as many as 14 new coal mines are about to be developed to supply the country's planned six new coal-fired power stations. The *Report* also praises the Club of Rome for its projected total depletion of all nonrenewable fuels and other minerals by 2100 (1974: Fig.35), and even brings forward some of the depletion dates, e.g. for gas, oil, nickel, copper, and zinc, to 2050 (2008: Table 3.3). It is far from clear why, if oil and gas reserves will be exhausted at the 2007 production rate by 2060 at the latest, the *Report* considers it necessary to include these fuels in its ETS. Turner (2008) correctly points out that the Club of Rome unlike the Ehrlichs (1970) did not forecast complete collapse of the world economy by 2000 as many have claimed it did, instead their terminal date "for collapse of the global system" due to depletion of non-renewable resources and rising [CO_2} was 2050 (Turner 2008). This is explicitly endorsed by the Garnaut *Review* with its encomium (p.69) on the Club of Rome, which would seem to suggest we should eat drink and be merry rather than attempt to stave off the inevitable with the damaging ETS.

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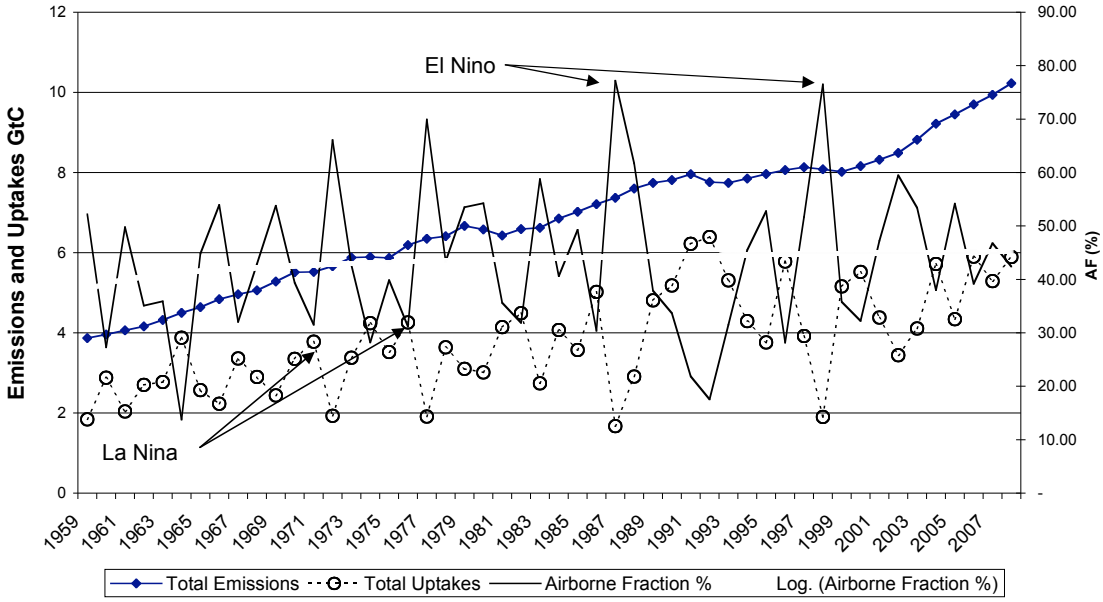
Fig.1 Emissions, Uptakes and Airborne Fraction of Emissions



Notes

1. The right vertical axis measures the Airborne Fraction (AF %) as the percentage of CO_2 emissions that remains in the atmosphere. Note that high AF years coincide with El Niño years and the low uptakes in those years (due to droughts).
2. The cited source shows that in 1959 3.87 GtC (billion tonnes of Carbon) were emitted by hydrocarbon fuel consumption and other sources of CO_2 emissions including land use change (LUC), and reached 9.94 GtC in 2007. The evident spurt in the growth trend after 2000 reflects rapid growth of hydrocarbon fuel usage in China and India amongst others.
3. The Total Uptakes curve shows the absorption of emissions by natural processes. Despite wide variability, invariably associated with the El Niño-La Niña (ENSO) phenomenon, the net effect is that the Uptakes track the Emissions remarkably closely on average, such that the log linear trend of the Airborne Fraction is basically flat after 1980.
4. That is because while evidently El Niño years result in the lower biospheric Uptakes depicted by the bottom curve (mostly via photosynthesis but including direct absorption by the oceans), La Niña years produce higher Uptakes, and hence produce a lower Airborne Fraction in those years. The annual average absorption of Emissions by Uptakes from 1959 to 2007, as shown by the source's mid-year data used here, is 56.5 percent of the Emissions.

Source: www.gmacweb.env.uea.ac.uk (accessed 23 October 2008, updated for July 2007 to July 2008 from NOAA).

Table 1
The Atmospheric Carbon Budget: Stocks and Flows

	Opening	Emissions	LUC	Total Em.	Uptakes	Closing	Airborne	Closing M.L.
	GtC	GtC	GtC	GtC	GtC	GtC	Fraction	ppmv
1959	668.47	2.46	1.50	3.96	2.01	670.42	0.49	315.59
1960	670.42	2.58	1.50	4.08	2.80	671.70	0.31	316.19
1961	671.70	2.59	1.50	4.09	2.35	673.44	0.43	317.01
1962	673.44	2.70	1.50	4.20	2.76	674.89	0.34	317.69
1963	674.89	2.85	1.50	4.35	2.92	676.31	0.33	318.36
1964	676.31	3.01	1.50	4.51	3.76	677.05	0.16	318.71
1965	677.05	3.15	1.50	4.65	3.14	678.56	0.32	319.42
1966	678.56	3.31	1.50	4.81	1.38	681.98	0.71	321.03
1967	681.98	3.41	1.50	4.91	2.94	683.96	0.40	321.96
1968	683.96	3.59	1.48	5.07	3.07	685.95	0.39	322.90
1969	685.95	3.80	1.48	5.28	2.69	688.55	0.49	324.12
1970	688.55	4.08	1.44	5.52	3.37	690.69	0.39	325.13
1971	690.69	4.23	1.29	5.52	3.65	692.56	0.34	326.01
1972	692.56	4.40	1.26	5.66	2.39	695.83	0.58	327.55
1973	695.83	4.64	1.25	5.88	3.57	698.15	0.39	328.64
1974	698.15	4.64	1.25	5.90	4.07	699.97	0.31	329.50
1975	699.97	4.62	1.25	5.86	3.18	702.65	0.46	330.76
1976	702.65	4.88	1.31	6.20	4.22	704.63	0.32	331.69
1977	704.63	5.04	1.32	6.35	2.57	708.41	0.60	333.47
1978	708.41	5.11	1.31	6.42	3.53	711.30	0.45	334.83
1979	711.30	5.40	1.28	6.69	2.69	715.29	0.60	336.71
1980	715.29	5.35	1.24	6.59	3.13	718.75	0.53	338.34
1981	718.75	5.19	1.26	6.45	3.16	722.05	0.51	339.89
1982	722.05	5.14	1.46	6.61	4.95	723.70	0.25	340.67
1983	723.70	5.13	1.51	6.64	1.82	728.53	0.73	342.94
1984	728.53	5.31	1.56	6.87	3.75	731.65	0.45	344.41
1985	731.65	5.46	1.58	7.05	4.48	734.22	0.36	345.62
1986	734.22	5.63	1.60	7.23	4.55	736.90	0.37	346.88
1987	736.90	5.76	1.61	7.37	2.81	741.46	0.62	349.03
1988	741.46	5.99	1.64	7.63	2.83	746.26	0.63	351.29
1989	746.26	6.11	1.65	7.75	4.91	749.11	0.37	352.63
1990	749.11	6.20	1.64	7.84	4.46	752.49	0.43	354.22
1991	752.49	6.31	1.71	8.02	6.41	754.10	0.20	354.98
1992	754.10	6.19	1.61	7.79	6.92	754.97	0.11	355.39
1993	754.97	6.20	1.59	7.80	5.01	757.76	0.36	356.70
1994	757.76	6.34	1.58	7.92	3.59	762.09	0.55	358.74
1995	762.09	6.49	1.56	8.05	4.44	765.70	0.45	360.44
1996	765.70	6.65	1.53	8.18	4.95	768.93	0.39	361.96
1997	768.93	6.84	1.49	8.33	3.74	773.52	0.55	364.12
1998	773.52	6.79	1.49	8.28	2.31	779.49	0.72	366.93
1999	779.49	6.80	1.45	8.25	6.21	781.53	0.25	367.89
2000	781.53	6.98	1.41	8.39	4.67	785.25	0.44	369.64
2001	785.25	7.12	1.39	8.50	5.38	788.37	0.37	371.11
2002	788.37	7.17	1.52	8.68	3.18	793.87	0.63	373.70
2003	793.87	7.50	1.51	9.02	4.19	798.69	0.53	375.97
2004	798.69	7.91	1.53	9.44	6.17	801.96	0.35	377.51
2005	801.96	8.17	1.47	9.64	4.22	807.38	0.56	380.06
2006	807.38	8.44	1.50	9.94	6.14	811.18	0.38	381.85
2007	811.18	8.72	1.50	10.22	5.78	815.62	0.43	383.94
				Averages 1959-2007				
		5.28	1.47	6.75	3.78	730.25	0.44	343.75

Sources: CDIAC; Canadell et al. 2007.