THE STERN REVIEW; A CRITICAL ASSESSMENT OF ITS MITIGATION OPTIMISM

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The Stern Review comes to highly optimistic conclusions regarding the possibility of solving the greenhouse problem, and the cost. The Key Message summary says that appropriate policies will allow strong economic growth to be sustained in both developed and developing countries, while making deep cuts in emissions. (p. 239.) the expected annual cost of achieving emissions reductions consistent with an emissions trajectory leading to stabilisation at around 550 ppm is likely to be around 1% of GDP by 2050 (p. 239.) The main conclusion is stated as, climate change mitigation is technically and economically feasible with mid-century costs likely to be around 1% of GDP (p. 240.) The Review has been widely quoted as having established these reassuring conclusions and they are being taken as axiomatic in the formation of policy and strategy.

The argument in this paper is that even if these statements are correct they are seriously misleading, mainly because the Review does not deal with most of the steps that must be taken to solve the greenhouse problem, it relies inappropriately on economic modelling and especially because it makes at least highly challengeable assumptions regarding the potential of renewable energy. Other reasons are given to support conclusions that are dramatically at variance with those of Stern, i.e., that the greenhouse problem cannot be solved without large reductions in aggregate world economic activity, possibly of the order of 75% or more, and therefore its solution is not compatible with the continuation of consumer-capitalist society.

It should be noted that the following discussion does not question the Review s account of climate science or its claims regarding the seriousness of the greenhouse problem.

1. <u>The carbon target is too high.</u>

The Review takes 550 ppm, double the pre-industrial level, as the target limit for the maximum concentration of CO2 in the atmosphere. However there is a strong case for concluding that a 400 to 450 ppm target runs a significant risk of producing more than a 2 degree rise in global temperature, and therefore of bringing about very serious consequences. The Tyndall Centre for Climate Change Research concludes that the goal should be no more than 450 ppm, meaning that a 90% reduction in the present rate of emission is needed. Baer and Mastrandrea (2007) indicate that Australia must reduce its domestic emissions by 95% by 2030. Hoehne (2006) and also Mills (2006) state much the same figures. Baer and Mastrandrea stress that even a 400 ppm limit would have a 9 ,Äì 16% probability of producing more than a 2 degree temperature rise. Many regard a 2 degree rise as an unacceptable risk. Pearce (2005) reports, At a recent climate conference many researchers concluded that the world should be aiming to keep CO2 concentrations in the atmosphere below 400 ppm. According to Stern s own Table 1.1, eleven studies indicate that a 400 ppm level could be associated with a remarkable 4.9 degree temperature rise, without taking into account any of the possible feedback effects (e.g., warming drying out wetlands and releasing methane.)

The Editor of <u>The Pacific Ecologist</u> received a personal communication from one of Stern s colleagues in Her Majesty s Treasury stating that the costs of stabilising below 450ppm would be extremely expensive , and that We do not say that 550 ppm CO2e is a safe level.

The situation is even more clearly evident in terms of carbon emission rates. The commonly quoted 2050 target level is a 60% reduction (which the above discussion indicates is insufficient), to about 2.8 billion tonnes of carbon p.a., and a reduction to about 1.5 billion tonnes towards the end of the century. However Stern s 2050 target (portrayed in Fig. 9.3, p. 230) only reduces carbon emissions to 5 GT by 2050.

Stern recognises how much more difficult the 450 ppm target would be by stating that for 550 ppm the rate of reduction would have to be 1% p.a but for the lower target it would have to be 7% p.a. (p. 201.) He says the reduction for the 450 ppm target would have to be by 70% (p. 201.) and he in effect says the associated cost to the economy would be unacceptable. This is also evident in the IPCC graphs where the 550 ppm reduction curve is not far below the present level by 2050, but the 450 ppm curve is much lower.

2. The 550 ppm target is far from achieved by 2050.

The Review seems to be saying, and has been widely reported as saying, that at a mere 1% of GDP cost we can do what is required to solve the problem. But this is far from what it is actually saying.

The emission reduction curve for a 450 ppm target to be achieved begins to fall from present levels soon, and rapidly. However the 550 curve is quite different; emissions can actually rise for some time and by 2050 do not have to have fallen far. Stern takes the level of this curve in 2050 as his target, and this corresponds to an emission of 18 GT, or 75% of the present level. The point is that this is all that has to be done by 2050 to be on that curve ‚Äì but it is just the beginning and a lot more would have to be done in the years after 2050 if the 550 ppm level was to be achieved eventually. Even if the 1% of GDP cost and the available alternative technologies would make it possible for us to be on curve in 2050, this says nothing about whether we can follow the curve all the way down to where it has to go. Where does it have to go? To about 28% of the present emission rate, whereas if Stern s proposals work we will only have gone down to 75% of it by 2050. In other words the necessary reducing will barely have begun by 2050 yet Stern s conclusion reads as if the steps he recommends will have solved the problem by 2050 by spending a mere 1% of GDP p.a.

In fact in the fine print Stern does recognise that long run stabilisation will require eventual reduction to under 20% of present emissions (p. 197), and possibly to 1 GT/y (15%) in view of evidence on the weakening of ocean absorption capacity.

The logic of Stern s argument would lead him to advise that one can travel around the world for almost nothing, which could be quite true, but seriously misleading if one has to pay most of the cost after the trip.

3. The energy target is too low.

Stern takes as the 2050 global energy consumption the amount that is also expected by the IEA (2007) and other agencies, which is around 2.5 times the present amount. But this is far below the amount that would be needed to provide present rich world per capita energy use to all 9 billion people expected soon after 2050. That would require more than 4 times the amount Stern takes as his target. If the target was the amount of energy needed to provide 9 billion people with the per capita consumption that we in rich countries are likely to have risen to by 2050, then given the anticipated growth rate the target is 9b x c200GJ x 2, i.e., 3,600 EJ, about 8 times the present world energy consumption. (The references below will mostly be to the exajoule equivalent of the carbon dioxide quantities Stern uses. The main assumption in deriving these is that Stern s 61 GT of carbon figure for 2050 business as usual world emissions roughly correspond to 2.5 times the present level, indicating that consumption would be c. 1100 EJ of primary energy. The various components such as wind and nuclear are derived as Stern s proportions of this total.)

Why should we consider the implications for 9 billion people? The choice here is either to assume that a few will go on taking most of the world s available energy, or endorse the goal of an equitable world. If the first option is taken we can expect to encounter increasingly serious problems of security and conflict. If the second is taken we have to accept that world average per capita energy use cannot rise to anywhere near present rich world levels, let alone the levels that growth in our energy consumption will lead to.

If we were to reach the expected IEA world 2050 energy production level and shared this equally, all would receive about half the present rich world per capita amount. Similarly, Anderson s figures (2006), used by Stern, assume 35,000TWh of electricity will be supplied in 2050. (Table 2.2a.) Shared among 9 billion people this would provide a per capita use only 37% of the present Australian figure, which is doubling at about 25 year intervals.

Stern s assumed biomass contribution, 110 EJ, would provide 9 billion people with an average of about 3% of the present Australian per capita liquid plus gaseous fuel use, after conversion of the primary energy to ethanol.

If Stern were to assume an equitable world distribution of energy, and to also hold the assumption implicit in conventional development thinking, i.e., that the free-market and growth-for-ever economy will in time raise all people to rich world affluence, then his task is to explain how 2050 world energy demand of almost 3,600 EJ can be met with only the 18 GJ of CO2 emitted Stern expects. That would be a ratio of energy to carbon emitted that is less than 3% of the present ratio. Again these figures refer to the 550 ppm task and if the 400 ppm or 450 ppm targets were taken the ratios would be much worse.

There is another major consideration which makes Stern s target much lower than it should be; the neglect of losses in converting energy from surplus to deficit forms. His Figure 9.4 indicates that 30% of final energy use (i.e., not the quantity of primary energy) will come from solar, wind hydro and nuclear sources. However only about 20% of Australian final energy (700 PJ of 3,400 PJ) takes the form of electricity. If we assume that the surplus 4% is solar heat used for heating, then we can regard electrical demand as having been accounted for. However the biomass figure assumed in Fig. 9.4, corresponding to 110 EJ of primary energy (which is unrealistically large; see below) would only provide about 36 EJ after conversion to ethanol for transport if it was all used for that purpose, i.e., 4 GJ/person averaged over 9 billion. This is a mere 3% of the present Australian per capita average consumption of liquid plus gaseous fuel, and about 6% of the per capita transport energy consumption.

Where would the other approximately 94% of transport energy, around 300 EJ come from? (This figure is derived from the fact that Australian per capita transport energy is 60 GJ per capita, and 35% of primary energy excluding that lost in electricity generation.) It cannot come from liquids produced from Coal Capture and Sequestration because emissions from vehicles cannot be captured. If it is to be supplied as hydrogen generated from electricity then a high loss must be dealt with. Bossel, Eliasson and Taylor (2003) estimate that for each unit of energy driving wheels via hydrogen 4 units of electrical energy must be generated. This would mean perhaps 1,200 EJ of electricity would have to be generated. If electric vehicles are assumed Bossel, Eliason and Taylor estimate the losses would be halved, so the figure might be 600 EJ.

However all of the remaining sources of primary energy represented in Fig. 9.4 plus the 100 EJ after meeting electricity demand, add only to 608 EJ. The 140 EJ that is CCS can t fuel transport, again because transport emissions can t be captured. That leaves 322 EJ of fossil fuel that can be burned according to Stern. This represents more than three times the world s present oil consumption, so most of it would have to be coal. However if 160 EJ of coal was used it would produce c 53 EJ of electricity and this would correspond to only about 26 EJ of energy driving wheels, according to Bossel, Gordon and Taylor (2003).

It can be seen therefore that Stern has adopted an energy target which is far below that which should be under discussion. Even if his target was achieved it would refer to a world in which a few still consumed most of the available energy. In particular it would seem that Stern could not explain how transport could be fuelled, especially when energy losses in conversion to transport fuel are taken into account.

4. <u>The unacceptable logic of the costing methodology</u>.

The most important criticisms of the Review are to do with the logic underlying the cost conclusions. Stern s method of estimating mitigation costs (Chapter 10, see also Anderson, 2006, p. 15) is to ask what would be the dollar cost of avoiding the emission of a tonne of CO2 by adopting conservation, wind, solar, biomass etc. technologies, then to simply multiply this by the volume of energy which his 2050 scenario assumes for each of these, and to total these dollar costs. This is the frequently used bottom up approach taken by economic modellers in estimating the costs of ecological action and especially carbon abatement costs.

The highly problematic assumption here is that one can go on replacing tonne after tonne of CO2 by paying for unit after unit of wind etc. at the assumed rate, <u>until the whole 43 billion tonne mitigation total has been accounted for</u>. In the real world there are likely to be several reasons why this is an invalid assumption, and the main reasons have little or nothing to do with dollar costs. The important problems and limits are not economic -- they are to do with whether or not the energy options which are viable and cheap at first become less available or indeed totally unavailable at some later point in time, i.e., whether or not savage limits to options are likely to be encountered as the scale of their adoption increases. What will be stressed below is that the scenarios Stern and others envisage involve extremely large multiples of present applications of alternative or non-fossil-fuel technologies.

To begin with the least important points, Stern does recognise the first problem here, the low hanging fruit or diminishing returns effect. Pollution reduction, energy conservation and efficiency improvements are typically subject to rapidly rising diminishing return curves; the first gains are the easiest but the options then become more scarce, difficult and costly, or dry up entirely. For this reason it is probably highly misleading to take the dollar cost of avoiding carbon release that we will have to pay when we start as a figure we can expect to go on paying.

Stern notes (p. 196) but does not seem to take into account one of the factors likely to cause diminishing returns, the fact that as temperature increases the carbon absorption capacity of soils and seas will deteriorate. (The IPCC Assessments have also been criticised for not taking these positive feedback effects into account, the reason given being that their scientific uncertainty has led to their absence from the reports which must be approved by many governments.)

Stern assumes that the opposite of diminishing returns will occur, i.e., that experience will see continual improvement in technical capacity to eliminate CO2. Anderson s Table 2.1 assumes a general decline from 225 pounds per tonne of CO2 abatement to 60 pounds by 2050 (p. 44, see also Stern p. 231.) There will of course be a tendency for technical advance to move costs in this direction but it is not at all clear that it will be stronger than the opposite, diminishing returns effect.

However the most important consideration regarding economic modelling is to do with the reasons for thinking that the strategies Stern assumes will be easily implemented in the early stages will run into savage limits. Some might suddenly cease being applicable at all. In fact, some might not be applicable from the start. For instance Chapter 6 of <u>Renewable Energy Cannot Sustain A Consumer Society</u> (Trainer, 2007) outlines the reasons why some believe there will not be a hydrogen economy, or the hydrogen powered vehicles Stern assumes. He does not deal with the analysis by Bossel, Eliasson and Taylor (2003) regarding the heavy losses in the production and distribution of the light hydrogen atom. In addition there would seem to be little doubt that the scarcity of platinum will rule out large scale use of fuel cells. (Gordon, Bertram and Graedel, 2006.)

Chapter 8 of Trainer (2007) sketches the reasons for thinking sequestration of carbon will not be viable, and Stern assumes sequestration will account for some 25% of his 2050 abatement achievement. Again note the scale of the problem. Stern s assumed 140 EJ under this category roughly corresponds to twice the amount of coal mined today. In other words he is assuming safe sites can be found for sequestration of about 20 billion tonnes of CO2 p.a. Obviously to focus on the present cost of storing a tonne of CO2 tells us little about the cost of sites for storage on the required scale, or whether sufficient sites are likely to be found. It is unlikely that very large scale sequestration will be attempted in deep ocean locations, because this would set formidable problems regarding stability over time in view of the disruption global warming will cause to ocean currents, and the fact that eventually carbon stored in the ocean will find its way back into the atmosphere. In any case CCS is not likely to extract more than 80 ‚Äì 90% of carbon from flue gases, indicating that either that the quantity Stern attributes to this category should be reduced by 10 - 15%, or some 3 GT of his 18 GT emission budget should be regardesd as having been used.

Chapter 9 of Trainer 2007 argues that nuclear energy cannot solve the problem, but Stern relies heavily on it. His assumed 2050 nuclear commitment, corresponding to 116 EJ and around 5 times the present nuclear capacity, would exhaust all the uranium resources Leeuwin and Smith (2005) believe are accessible within a few years. For 9 billion people this would provide 13 GJ/y/person, about one third of the present Australian per capita electricity consumption. Overlooked is the fact that there would be times when nuclear plus coal would have to take almost the entire load assumed for solar electricity and wind, i.e., the times when winds are down at night. If the nuclear sector is to be capable of providing 9 billion with 2 KW per person (i.e., assuming that is rich world consumption by 2050), then it would have to generate around 570 EJ/y, more than 11 times present world electricity supply and about 65 times the present world nuclear contribution.

The Review does not deal with the possible limits to the extension of renewable energy technologies. For instance Stern assumes wind will provide some 30 times the present amount of energy it generates, with no assessment of whether enough sites for this are likely to be found. (He does recognise this could be a problem.) Some European countries are already probably close to their limits. Stern s assumed wind contribution, 62 EJ, corresponds to almost 250 EJ of peak capacity, given the typical .26 capacity achieved by the whole UK wind system located in what is probably Europe s best wind region. Present wind costs would give no indication of the effects of greatly increased demand on the cost of sites or on the quality of the sites available and the resulting capacity factor.

The most significant problems in Stern s discussion of renewables are to do with the provision of transport fuels, and the assumed role of biomass. He does not show that biomass can meet the huge demand it would be subject to in a renewable energy world. Chapter 5 in Trainer (2007) details the reasons for concluding that biomass cannot provide more than a very small fraction of present liquid fuel demand, probably in the region of 5%. There is far too little forest or land for biomass to meet a significant proportion of demand. Regardless of how optimistic assumptions about future technology and yields are, there would seem to be no possibility of replacing fossil transport fuels with ethanol or methanol etc. As has been explained above it is not plausible that transport can be run on hydrogen or on electricity produced by renewable energy.

The amount of biomass Stern assumes, 110 EJ, could be feasible (e.g., 870 million ha at a 7/t/ha yield), yet it would enable only a tiny proportion of present world transport fuel, in the region of 36 EJ of ethanol. As has been explained above, for 9 billion people this would be an average of 4 GJ per person per year, or 3% of present Australian per capita oil plus gas consumption, or 7% of present per capita transport energy consumption.

Stern does not discuss the major limits for wind and solar power, the difficulty of integrating these highly variable sources into the grid, and the impossibility of storing large volumes of electricity. (See Chapters 2 to 4, and 7 of Trainer, 2007.) He does note that the contribution intermittent energy sources can make cannot be very significant unless some way of storing very large quantities of electricity can be found. Some means of storing the energy will be required. (p. 5 and p. 227.) He proceeds as if ways will be found, with no discussion of the reasons for thinking that this is unlikely. (Trainer, 2007, Ch. 7.)

The integration problem leads to another reason why Stern s Fig. 9.4 gives a misleading impression regarding capital costs, i.e., the omission of the cost of necessary back-up generating capacity. According to E. On Netz, the biggest German wind company, this might have to be equivalent to 80% of the wind plant capacity. Nor will Stern s Fig. 9.4 have included the cost of restructuring the grids to take large amounts of energy suddenly from wherever the winds are up, also stressed by E. On Netz reports. (E.On Netz, 2004, 2005.)

More importantly, Stern fails to deal with the fact that renewable energy sources are best thought of as alternative, not additive. For instance the solar contribution represented would be equivalent to about 1,400 power stations (1000 MW each at .8 capacity). However those power stations would work only about 6 ,Äì 8 hours a day on average, so for the rest of the time another 1,400 power stations would be needed to substitute for this solar contribution. There will be calm and cloudy times when coal or nuclear would have to almost entirely substitute for total wind plus solar electricity capacity. Thus it can be seen that renewables are, not sources that can be added to coal or nuclear sources, but sources that can at times be used as alternatives_to coal/nuclear sources. They save on fuel use, but they increase total system capital costs, because they involve duplication of plant (or more, where solar thermal, PV, wind and other systems are to be integrated into a coal fired system.) Stern s Fig. 9.4 treats solar and wind as additive sources. It represents fuel quantities, not quantities of plant or capital, and these capital costs to do with the duplication of plant have not been taken into account. He assumes that adding 1 GW of solar and 1 GW of wind capacity to a system means its generating capacity has been increased by 2 G GW, when there will be many periods when the addition will in effect be close to 0; i.e., on calm nights.

When we include the different capacity factors in the calculations (coal .8, wind .26 for the UK system, PV .2-), along with their different peak watt capital costs (e.g., $A1,400 for coal, $A1,500 and possibly $A2,000+ for wind, and $A10,000 for PV, see Trainer 2007), it seems that a total, integrated system with coal, solar and wind peak capacities each equal to average demand would cost around 13 times as much as a system using coal generation on its own (or about 7 times when the cost of coal is included). Stern s costing has not taken into account this need for overlapping or duplicated plant arising from the fact that renewables cannot be regarded as additive power sources.

This indicates why the share of total demand met by any one renewable source is not likely to be greater than its capacity factor. If it was higher there would be times when it generated more than demand and energy would have to be dumped. Some movement in this direction might make sense, but not much, as capital costs would rise more rapidly than energy delivered. For example, to have peak capacity equal to twice demand would mean that wind would generate c .6 of demand but perhaps 20% of this would have to be dumped. (See the aggregate diagram in Oswald Consulting, 2006, p. 8.)

A recent study by Oswald Consulting (2006) provides important modelling evidence on the probable pattern of electricity supply from a wind system spaced across the entire UK, possibly the best wind region in the inhabited world, and in January, the best month for wind energy. The aggregate supply pattern is remarkably irregular, with output ranging from 95% of capacity to zero, and falls from 80% to 20% in10 hour periods. It is evident from this that if wind was to supply more than about one-third of total electricity demand energy dumping would have to occur and more importantly that coal or nuclear sources would have to substitute for the almost entire wind system two or three times a month. There would be almost no capacity credit , i.e., almost no coal or nuclear power stations could be retired because there would be times when there was little wind.

Over-sizing the wind system so that it dumped much energy at times but contributed a higher fraction of total demand would reduce the need for coal or nuclear fuel use, but this would hardly affect the need for back up capacity to be built. The gaps in the supply pattern are so significant that even a wind system so oversized that it had to dump one-third of the energy it generated would still require the use of much more coal than would be safe for greenhouse emission reasons. It should be stressed that the graph in question is for January (averaged over several years) and this is the best time of the year for wind in the region. Had this discussion been based on the July or annual average situation the implications would have been more marked.

In addition there is the problem of how quickly the non-renewable sources can be ramped up to full output. On most days solar output would go from zero to 100% of capacity in about 2 hours and it is not possible to bring coal or nuclear plant up to or down from full output in such periods. This would not be a problem if the renewable fraction of total supply was small, but the focus in this discussion is on the situation when it is large. It is possible to ramp up gas-fired plant more quickly, but this would set difficulties regarding the cost of having overlapping and therefore idle gas plant, the rapid depletion of gas resources, inefficiency due to operating plant at varying levels, and exceeding the carbon capture and storage budget.

To summarise, Stern assumes quantities of energy from CCS, biomass, wind and nuclear sources which seem to be clearly impossible to achieve, even ignoring the above implications for losses in the necessary conversion from one form of energy to another. The reasons have little or nothing to do with economics or dollar costs but are to do with limits to the amount of capacity that can be developed. It is remarkable that an examination of some of the main contributions to the large literature on the economic modelling of the possibility and costs of carbon abatement reveals no reference to any possible limits to alternative energy sources. (Toll, 2006, and Nordhaus, 2007, are modellers who conclude that Stern has greatly over-estimated the cost of CO2 mitigation, without any consideration of the technical limits discussed here.) It appears therefore that by neglecting these factors the Review has come to seriously misleading conclusions. (Apparently the IPCC Fourth Assessment is subject to the same criticism, judging by the Summary for Policy Makers.)

These considerations constitute a fundamental indictment of the narrowness and inadequacy often evident in conventional economic analysis. Conventional economic theory attends only to dollar values and therefore cannot take into account many important costs and benefits of production, consumption, exchange and development, such as the boredom of factory work, ecological damage, the psychological costs of unemployment, the loss of community, and the spiritual costs inflicted on the excluded classes. The general result is a discourse which favours the interests of capital (since non-dollar costs of production are ignored and therefore not paid by investors), but in the present instance the distortion is even more serious. Economic modellers conclude that the cost of carbon abatement will be negligible because they do not attend to any of the many factors which have nothing to do with dollar costs but which actually indicate that the cost will be impossibly great. Their discussions are akin to an attempt to theorise about art with a vocabulary confined to the thickness of paint. However that would only fail to deal with the things that matter about art. In the case of the Stern Review the inappropriate reliance on economic models appears to be reinforcing catastrophically mistaken interpretations regarding our perilous global situation.

Other difficulties.

Anderson (2006, p. 60) says bio-ethanol can be produced at 2.5 ‚Äì 3.5 kWh/m, equal to 2 ‚Äì 3 tonnes of oil per ha. This is not a plausible figure as it is about 2.5 times the approximately 7 t/ha rate that cellulosic biomass is likely to be harvested from very large land areas (even without taking into account the implications of the greenhouse effect, especially the reduced availability of water for biomass production.)

Anderson s Figure 2.2b shows 2050 petrol and diesel consumption of about 290 EJ, some 70% greater than at present. Many believe oil supply is nearing its peak and will be down to a small fraction of the present quantity by 2050.

Stern s Box 9.4 predicts a dramatic fall in the cost of PV technology, but the cost of PV modules has ceased falling in the recent past (although this might have been due to silicon supply issues; see Trainer, 2007, Chapter 4.)

Finally, no account is taken of the implications of much higher energy prices for all the calculations feeding into the Review and its conclusions. Energy is likely to cost a lot more before long, and this will multiply into the costs of building alternative plant, as all involve use of energy-intensive materials and require energy for their production.

Conclusions.

These have been reasons why the Stern Review is at least highly misleading regarding the possibility of greenhouse abatement. Its basic message, mitigation of climate change is technically and economically feasible (p. 240) has not been shown and indeed hardly discussed, given that the Review does not deal with the large steps that would have to be taken after 2050 to achieve mitigation. More importantly the Review does not deal with the reasons for thinking that it will not be possible to take the steps assumed on the scale required. It relies on bottom up economic modelling which makes no reference to the main factors determining the possibility and costs of abatement, i.e., the difficulties and limits involved in renewable technologies.

Contrary to Stern, the figures and arguments outlined above support the conclusion that given the commitment to affluent living standards and economic growth the greenhouse problem cannot be solved at any cost. This is mainly because a) the action that would be required goes far beyond that which Stern assumes to be necessary, and b) there are limits to the use of renewable energy technologies which will even prohibit them from making the insufficient contribution Stern assumes. If these arguments are valid then the greenhouse problem cannot be solved without very large scale reductions in the level of global production, consumption, GDP etc.

The central argument in Trainer (2007) is that affluent consumer society is not viable, not solely because it is far beyond sustainable resource use levels but also because it is built on an extremely unjust global economic system which delivers to the consumer societies far more than their fair share of the world s wealth. An examination of energy, mineral and biological resources shows that rich world material living standards are far higher than all people on earth could rise to. Chapter 10 of the book summarises these arguments, concluding that there is no solution to the alarming global predicament without huge and radical transition away from the obsession with affluence and growth and to some kind of Simpler Way (Trainer, 2005a). This is detailed in Chapter 11 where it is argued that workable and attractive alternative ways are available, and would have very low energy and footprint implications. However these ways could not be followed without the adoption of very different economic, political and above all value systems, and it is not being assumed that a transition to The Simpler Way is likely. (On the prospects for transition see Trainer 2005b.)

Unfortunately Stern’s Review, along with many other commentaries, especially from Green sources, reinforces the belief that there is no need to think seriously about moving from consumer-capitalist society because not only are there ways in which such a society can solve problems such as greenhouse, but these can be implemented at negligible cost.

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