WHAT IF STERN IS WRONG?

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This article challenges several of the core assumptions on which the report on the Economics of Climate Change by Nicolas Stern is based. These include Stern's estimates of the potential for renewable energy and the capacity for carbon capture and storage in the combustion of fossil fuels for electricity.

Over the past few years there has been a remarkable surge in interest in the greenhouse effect and energy problems. It is now generally accepted that climate change is occurring, that it is due in large part to human activity, and that it is serious. Perhaps less well understood but also enjoying a remarkable increase in concern is the 'peak oil' thesis: the claim that we are close to the peak in petroleum availability and that this event is likely to bring about major economic disruption, unless substitutes are developed.

The report written by Nicolas Stern[1] has attracted widespread attention and appears to have been unanimously accepted as having established two crucial conclusions. The first is that the greenhouse problem can be solved, and the second is that it can be solved at negligible cost by 2050. I have written a detailed critique of the review[2] and will only briefly summarise the main difficulties here, before pointing to the profound implications that follow if Stern's conclusions are mistaken. My argument is that both Stern's conclusions are wrong: that the greenhouse problem cannot be solved in a consumer-capitalist society, at any cost. If this is so, then Stern has seriously misled the world, and current mitigation strategies cannot solve the problem.

THE CARBON TARGET IS TOO HIGH

The Stern review takes 550 parts per million (ppm), double the pre-industrial level, as the target limit for the maximum concentration of CO_2 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 two degree rise in global temperature, and therefore of bringing about very serious consequences. Stern takes as his target reducing total CO_2 emissions from the present 26 giga tonnes per year (GT/y) to 18 GT/y in 2050. It is now generally accepted that global temperature increase should not be allowed to exceed two degrees Celsius. The Intergovernmental Panel on Climate Change's (IPCC) emission scenarios show that this would require the present level of emissions to be cut by 50 to 80 per cent by 2050 (or to 5 to13 GT/y), and more or less eliminated entirely by 2100.[3] In the absence of mitigation efforts Stern indicates that CO_2 emissions could grow to 58 GT/y by 2050.[4] Stern has therefore taken a target that is well above what it ultimately has to be.

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 one per cent per annum but for the lower target it would have to be seven per cent per annum.[5] He says the reduction for the 450 ppm target would have to be 70 per cent and he, in effect, says that the associated cost to the economy would be unacceptable. The 7 graphs in the IPCC summary for policymakers (SPM) also show that the 550 ppm reduction curve is not far below the present level by 2050, but the 450 ppm curve is much lower.

It is increasingly accepted that the IPCC has significantly underestimated the pace and magnitude of climate change, partly because of the difficulty in taking into account feedback mechanisms such as the reduced capacity of warmer sea water to absorb carbon dioxide. Therefore it is likely that in future the desirable target will be seen to be under 400 ppm.

AN INAPPROPRIATELY LOW ENERGY BENCHMARK IS ADOPTED

Stern takes as the 2050 global energy consumption benchmark (under business-as-usual conditions) the amount that is also anticipated by the International Energy Agency[6] and other agencies, which is almost 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 nine billion people expected soon after 2050. That would require more than four times the amount Stern takes as his target. If the target were the amount of energy needed to provide nine billion people with the per capita consumption that Australians are likely to have risen to by 2050 then, given the anticipated growth rate, the target is 9 billion x circa 200 gigajoules (GJ) x 2, that is, 3,600 exajoules (EJ)—an EJ is equivalent to the energy content of approximately 42 million tonnes of coal. This is about eight times the present world energy consumption.

Why should we be concerned with whether the lifestyles and systems that rich countries have and aspire to in future could be shared by all, that is, whether the resources and ecological processes of the planet would make this possible? If they would not, then the rich countries are confronted firstly by the moral question of the acceptability of resource-expensive ways which it is not possible for all to have, and only possible for them if they continue to take far more than their fair share. Whether or not they choose to ignore this moral question, they will not be able to ignore the geopolitical reality. This is that the rest of the world is determined to rise to rich world affluence, so we will have no choice but to grapple with the implications of nine billion people trying to live in the ways we aspire to. If this is not possible then intense conflict over access to resources is likely.

Thus even if Stern's target can be achieved we should keep in mind that it would have to be associated either with gross global energy inequity, or far lower rich-world per capita energy use rate than at present. (The implications for an energy-affluent world of nine billion are given at various points below. Readers can form their own judgments regarding the significance of the issue.)

THE REQUIRED MITIGATION TARGET IS NOT ACHIEVED

Stern is taken to be saying that the greenhouse problem can be solved by 2050 by the (almost costless) measures he discusses, and represents in his Figure 9.4. In fact this is not what he is actually saying. He is saying that in order to be on a path that would solve the problem eventually, the steps we would have to take by 2050 would not cost much. He argues that this cost would only be equivalent to about one per cent of GDP by 2050.[7] But we would have to take drastic steps after 2050. Even if the one per cent 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. It has to go down to about 28 per cent of the present emission rate, whereas if Stern's proposals work we would only have gone down to 75 per cent of the present rate 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 at a cost of only one per cent of GDP per annum.

The situation is clear in the IPCC Fourth Assessment Report diagrams.[8] The fourth diagram, showing the path to Stern's 550 ppm target, allows a marked increase in emissions by 2050, to around 30 GT/y—but then shows that they must fall to about 7 GT/y by 2100. In the fine print Stern recognises this point, but does not focus on it.

THE INVALID USE OF ECONOMIC MODELING STUDIES

The most important criticisms of the review are to do with the logic underlying the cost conclusions. Stern's method of estimating mitigation costs is to ask what would be the dollar cost of avoiding the emission of a tonne of CO_2 by adopting conservation, wind, solar, biomass technologies and so on. He then simply multiplies this dollar cost by the volume of energy which his 2050 scenario assumes for each of these mitigation strategies, and totals these dollar costs (see his Chapter 10). This is the frequently used 'bottom up' approach taken by economic modelers in estimating the costs of mitigation action and especially in estimating carbon abatement costs.

The highly problematic assumption here is that one can go on replacing tonne after tonne of CO_2 by paying for unit after unit of wind and so on at the assumed rate, until the whole 43 billion tonne mitigation total has been accounted for. As indicated Stern assumes energy production, if produced as at present, will generate around 58 GT/y by 2050. Since his target is to reach 18 GT/y by 2050 this means he is explaining how 40 GT/y can be eliminated by using alternative strategies plus conservation. In other words, Stern's target is to deliver the amount of energy 'services' that would generate 58 GT/y of emissions if provided as at present, but via alternatives which would reduce emissions to 18 GT/y.

As indicated, the main problem with Stern's analysis is that he ignores the possibility that energy options which are viable and cheap at first will become less available or indeed totally unavailable at some later point in time. This is because savage physical, biological and technical limits to options are likely to be encountered as the scale of the adoption of these strategies increases. The scenarios Stern and others envisage involve extremely large multiples of present applications of alternative or non-fossil-fuel technologies.

For instance, Stern assumes geo-sequestration of carbon dioxide (carbon capture and storage or CCS) will account for some 18 per cent of his 2050 abatement goal, or 7.7 GT/y. While this could be feasible, CCS would have to be practised on a far greater scale if the arguments above regarding appropriate targets, and below regarding the limits of renewables and nuclear energy, are valid. It is unlikely that very large scale sequestration will be attempted in deep ocean locations. This is because it would pose formidable problems regarding stability over time in view of the disruption global warming will cause to ocean currents and to the absorption capacity of sea water, and the fact that eventually carbon stored in the ocean will find its way back into the atmosphere. According to Hendricks, Graus and van Bergen,[9] the best estimate of land storage capacity is 1700 GT. At the rate Stern assumes this storage capacity would last a long time, but if we assume that in the long term CCS must deal with 25 per cent of a 2050 world energy budget that would provide nine billion people with levels of energy consumption expected for Australia, the CCS rate would have to be around 121 GT/y and the above storage capacity would then last 14 years.

The more responsible emission path given in IPCC 2007, SPM Figure 7 indicates that by 2100 CO_2 emissions probably must be entirely eliminated. This would seem to disqualify use of CCS because it only removes 80 to 90 per cent of CO_2 generated.[10] In any case it can only be applied to the 40 per cent of energy produced at stationary sources.[11]

Stern relies heavily on nuclear energy. His assumed 2050 nuclear commitment, corresponds to 116 EJ and is around 15 times the present nuclear capacity. This would exhaust all the usually quoted uranium resources (3.7 to four million tonnes) within a few years.[12] For nine 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, that is, the times when winds are down at night. If the nuclear sector were to take half the load for a world of nine billion on expected 2050 Australian consumption levels, installed capacity would have to be around 2200 EJ, some 275 times present nuclear generation.

The review does not deal with the possible limits to the extension of renewable energy technologies. For instance Stern assumes that wind will provide 62 EJ, around 150 times the present amount of energy wind generates, with no assessment of whether enough sites for this are likely to be found, within reasonable distance of demand. (He does note that this could be a problem.) Some European countries are already probably close to their limits. Present wind costs would give no indication of the effects of greatly increased demand on the cost or 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. Chapter 5 in Trainer (2007)[13] 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 five per cent. There is far too little forest or land for biomass to meet a significant proportion of demand. For instance, if nine billion people were to have the present Australian oil plus gas consumption in the form of ethanol from biomass (assuming seven tonnes per hectare) and 7GJ/tonne ethanol yield then 23 billion hectares (ha) would have to be harvested, on a planet with a total land area of only 13 billion hectares. 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.

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 produce only a small proportion of present world transport fuel, in the region of 36 EJ of ethanol. Assuming a net efficiency in conversion from biomass to ethanol of around 30 per cent, averaged across nine billion people, this would provide four GJ per person per year, or three per cent of present Australian per capita oil plus gas consumption, or seven per cent of present Australian per capita transport energy consumption.

Stern mentions but 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—'... some means of storing the energy will be required'.[14] He proceeds as if ways will be found, with no discussion of the reasons for thinking that this is unlikely. (These are considered in Trainer, 2007, Chapter 7. Chapter 6 discusses the reasons why a 'hydrogen economy' is unlikely.)

The integration problem leads to another reason why Stern's Figure 9.4 gives a misleading impression regarding capital costs, that is, 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 per cent of the wind plant capacity. Nor will Stern's Figure 9.4 have included the cost of restructuring the grids to take large amounts of energy suddenly from wherever the winds are strong at a point in time, also stressed by E. On Netz reports.[15] 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 0.8 capacity). However, if these were PV power stations they would work only about six to eight 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 sources 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. Stern's Figure 9.4 treats solar and wind as additive sources.

To summarise, Stern's 2050 pathway assumes quantities of energy from CCS, biomass, wind and nuclear sources which would seem to be impossible to achieve. The reasons include economics or dollar costs as well as the limits to the amount of capacity that can be developed or used. It is remarkable that an examination of several of the main contributions to the large literature on the economic modeling of costs of carbon abatement reveals no reference to any possible limits to alternative energy sources. (Toll and Nordhaus are modelers who conclude that Stern has greatly over-estimated the cost of CO_2 mitigation, without any consideration of the technical limits discussed here.)[16]

CONCLUSIONS

The Stern review's basic message, '… mitigation of climate change is technically and economically feasible …'[17] has not been shown. He has adopted a carbon target that is much too high, and an energy supply target that is much too low. He has focused on the level of emissions in 2050 consistent with being on track to achieve his 550 ppm goal by 2100, without stressing the dramatic reduction that would be needed after 2050. Most importantly, he has failed to deal with the many important reasons why alternative technologies might not be able to make the contributions he assumes. Contrary to Stern, the figures and arguments outlined above support the conclusion that within a society committed to affluent living standards and economic growth no solution to the greenhouse problem can be found, at any cost.

The radical implications for thinking about policy

Stern's widely accepted conclusions have reinforced the dominant convictions that consumer-capitalist society is viable; changes are needed, but these can be made. The central argument in Trainer (2007) is that the affluent consumer society is not viable, not solely because it is far beyond sustainable resource and ecological limits but also because it is built on an unjust global economic system which delivers to the few in rich countries far more than their fair share of the world's wealth. An examination of energy, mineral and biological resources and of footprint analysis indicates that rich world material living standards are much higher than all the people on earth could rise to, perhaps by a factor of 10. What is not generally recognised is the magnitude of the overshoot, and thus the huge reductions required. Chapter 10 of the book summarises these arguments, concluding that there is no solution to the global predicament without radical transition to some kind of Simpler Way.[18] It is not just that consumer-capitalist society is unsustainable; the point is that it cannot be made sustainable. A sustainable society that all could share could not have anywhere near the levels of production and consumption presently taken for granted in rich countries, and would have to have a zero-growth economy.

These and other necessarily principles for *The Simpler Way* are outlined 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 quite different economic, political and above all value systems centred on frugality, self-sufficiency and non-material satisfactions. These represent enormous contradictions of several fundamental elements in Western culture, so the chances of achieving transition to *The Simpler Way* would have to be judged as minute.[19] Unfortunately Stern's review reinforces the belief that there is no need to think seriously about moving from the commitment to affluent living standards and economic growth. He has reinforced the faith that, not only are there ways in which a society committed to affluence and economic growth can solve problems such as greenhouse, but that these ways can be implemented at negligible cost.

References

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19. On the prospects for transition see F. E. (T.) Trainer, *Thoughts on the Transition*, 2005 <http://ssis.arts.unsw.edu.au/tsw/15-Transition.html>.