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Page

> What are the key attributes of this species that might explain its unleashing of an extinction spasm predicted to rival the great dyings of past geological epochs? Technology, the outpouring of the unparalleled human capacity for invention is one obvious answer. Closely linked are the ongoing growth in human numbers — population — and the materials-processing behavior of average individuals — consumption. According to the late anthropologist Marvin Harris, population growth and the evolution of technology are in a perpetual dance. Technology solves problems created by dense populations, and these solutions then enable populations to grow even denser, thus creating new problems for which new technological solutions must be sought.
>
> Robert Engelman *The Many, the Voracious, and the Lethally Successful*

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INTRODUCTION

In this issue, we look at three books which have been published fairly recently. *The Solar Fraud: Why Solar Energy Won't Run the World* (2nd edition), by Professor Emeritus of physics Howard Hayden, is important because it presents the truth about solar energy, and thereby serves to counter the multitudinous hordes of 'energy fantasists,' whose absurdities and erroneous predictions he quotes to good effect. Unfortunately Hayden fails to follow his analysis to its logical conclusion, namely that without fossil fuels, it will be possible to support only a much smaller population.

Energy at the Crossroads is important because the author, Professor Vaclav Smil, is an outstanding scholar of everything connected with energy, yet on the subject of solar energy he edges towards the camp of the 'energy fantasists'. You do not need to take my word for that, because, on pp. 9–13, I lay bare the subterfuges by which Smil convinces himself that things are more or less the way he would wish them to be, rather than the way Hayden shows that they actually are.

The Collapsing Bubble, by Lindsey Grant, is a book that it is hard to over-praise. In only 74 pages Grant takes a balanced view of what lies ahead, and what needs to be done about it. Importantly, he recognizes that it is essential to start with the USA. Our founder, David Willey, greatly admired Lindsey Grant's writing, so I am particularly pleased to have found this little book so outstanding.

Something of a theme in this issue is the human tendency to delusion. Edmund Davey's piece, on pages 15–17, appeared in OPT's in-house magazine *Jackdaw*, but it is relevant to our theme, and seems to me of sufficient importance to be given a wider airing.

The Depth of Delusion, pp. 18–20, relates to an admirable organization Media Lens, the purpose of which is to expose the extent to which, consciously or subconsciously, writers in the media avoid anything that might cause unease to the nation, such as doing something realistic about global warming. Interestingly, so pervasive is delusion, that Media Lens itself suffers from the delusion that the "Contraction and Convergence" solution can be a realistic solution *without also reducing population to about 2 billion*.

Web of Deceit, pp. 21–22, is the title of a book by Mark Curtis, from which representative extracts are taken. Curtis muses over the reasons for the 'deceit' that he exposes and decides that the cause is often self-serving delusion.

The Roots of Delusion: a Quest, pp 23-25, has also appeared in *Jackdaw*, but is repeated here as it seems particularly relevant to the 'delusion theme' of this issue.

According to the report in *New Scientist*, 2nd April 2005, the *Millennium Ecosystem Assessment Synthesis Report* cost $24 million and involved more than 1300 'experts'. As described on pp. 26–28, it failed dismally to see the implications of what it discovered.

I asked John Gray and Edward Goldsmith to respond very briefly to this question: "Given the existing human condition, what 'cast of mind' is best suited to cope with it (and therefore to be promoted in schools and universities)." Their responses are on page 29.

In *Scientific and Journalistic Goofs*, pp. 30–32, the extracts taken from a paper by Professor Emeritus of physics Albert A. Bartlett show that even those who strive to avoid delusion have a hard task, because misinformation in the media abounds.

As usual this issue has depended on the useful input of many others. I am grateful to Ted Trainer for passing on data from Milton Maciel, a sugarcane farmer in Brazil with much expert knowledge. Martin Desvaux greatly improved some of my text with his eye for good style. David Pimentel's suggestions led to many an improvement, with his deft ability to put his finger on the essence of the issue. Yvette Willey did her usual superb job of proof reading, picking up those little errors which had passed me by.

The Solar Fraud: Why Solar Energy Won't Run the World, by Howard C. Hayden

A Review Essay (based on the 2nd edition) by Andrew R.B. Ferguson

It was a singular moment when, in 2001, Howard Hayden published his book *The Solar Fraud*: *Why Solar Energy Won't Run the World*. For here was a Professor Emeritus of physics, who was prepared to take on the small army of wishful thinkers among the ranks of which are the Worldwatch Institute, the National Renewable Energy Laboratory, the Rocky Mountain Institute, Friends of the Earth, Greenpeace, New Scientist, and a veritable horde of populist writers forecasting a 'hydrogen economy'. It is good to see that the book received so much attention that all copies of the first edition sold out, and by early 2005 Hayden was sending out copies of a revised and expanded edition.

In his preface to the second edition, Hayden says, "There are more comments from the loony bin. It could be argued that I have entirely too many ridiculous quotes from that quarter, but I disagree. It is precisely those self-styled experts whom the news media seek for comments, and they should be countered." How true that is. Even the BBC is guilty of interviewing Amory Lovins as though he were a genuine expert. In the field of energy, it seems that those who are responsible for selection in the media cannot distinguish between popular 'experts' and those, like Howard Hayden, who actually know what they are talking about.

There are, of course, other people who know what they are talking about in the field of energy. David Pimentel of Cornell university has produced many papers on the subject, and the book *Food*, *Energy*, *and* Society, written with his wife Marcia, is a landmark, but it does not, of course, focus entirely on matters of renewable energy. That is the strength of Hayden's book. He looks at all the solar possibilities (pipe dreams?) in turn, and shows that they do not cut the mustard. He does this by introducing the reader gently to the concept of power densities, that is the amount of useful power that can be captured directly or indirectly from the sun, within a specified area. For this purpose, he explains to the reader the benefits of expressing all measurements in standard units, of joules, watts, metres and seconds. He is certainly right in suggesting that it is time to do away with the likes of calories, Btus, acres, cords and langleys!

His careful evaluation of each solar energy source, which is the substance of the book, is summed up in Table A10 (p. 242). It shows the power densities, in watts/m^2 (W/m^2) of land area, for various solar sources. Although he does not mention the point, the energy intensity (power density) of producing synthetic gasoline from coal is about 40 W/m^2, and oil and gas are probably around the average solar intensity in the USA of 200 W/m^2. Those figures help to put the following measly ones, from Table A10, into perspective.

Corn (whole plant)	0.75	W/m^2
Ethanol from corn (gross)	0.195	W/m^2
Ethanol from corn (net, best conditions achieved)	0.047	W/m^2
Hoover dam (average power divided by collection area)	0.0014	W_e/m^2
All US dams (average power divided by collection area)	0.0049	W_e/m^2
Typical wind farm (with winds *from random directions*)	1.2	W_e/m^2

Note that almost everyone who actually installs wind turbines works on the assumption that the wind may come from random directions! Hayden's table includes one error (which exists also in the main text). He ascribes to "sugarcane (whole plant, tropical conditions, plenty of fertilizer and pesticides)" a power density of 3.7 W/m^2. For some reason, most people seem to get confused about sugarcane; that was my reason for writing *Sugarcane and Energy*.[1] Perhaps the explanation lies in the high moisture content of the fresh plant. Over extensive areas of Brazil, yields of 80 t/ha/yr of sugarcane stalks are now being obtained. These contain 18 t dry mass. They would be associated with 16 t of cane tops + green leaves (2.9 t dry mass), and 8 t of 'dry' leaves (7.2 t dry mass). Thus the total dry mass content associated with a 80 t/ha/yr yield is 28.1 t. As Hayden himself points out, the energy content of dry biomass is fairly constant. He gives 15 GJ/t, but my references put it at 17.5 GJ/t.[2] Even at 17.5 GJ/t, the energy content of 28.1 t/ha/yr is only 492 GJ/ha/yr = 492 / 31.5 = 15.6 kW/ha = 1.56 W/m^2 (not Hayden's 3.7 W/m^2).

So Hayden's 3.7 W/m^2 is wrong, but then sugarcane seems to lead everyone astray. Slesser and Lewis, in their book *Biological Energy Resources*[3] sang the praises of sugarcane on the basis that the ethanol yield from sugarcane would be 17 t/ha/yr. The correct average figure would be about 4.3 tonnes of ethanol/ha/yr = 0.37 W/m^2.

Looking at Slesser and Lewis is something of a diversion, but it brings out the point that few books are entirely free from errors. In Hayden's book there are some, as mentioned in Appendix A, but essentially Hayden tells it exactly how it is with regard to solar energy.

One might censure him for not looking at the wider picture. That is to say, if his arguments are right — which surely they are — and solar energy won't run the world, and if it is true that fossil fuels have a limited life, which Hayden accepts as likely for gas and oil, though he is briefly more optimistic about coal (ignoring the carbon emissions), then there is an obvious corollary: we need to use the remaining time while fossil fuels are available to reduce population to a possibly sustainable 2 billion. Although Hayden is right to say that renewable energy cannot run the *present* world, there is a fair chance that it might run a world of only 2000 million humans.

It is surprising how many wise heads manage to overlook this obvious corollary, and indeed may overlook other things in order to allow themselves to overlook it! Vaclav Smil, in his *Energy at the Crossroads*,[4] thinks of coal as a more or less endless energy source, but conveniently forgets that more energy will be spent getting it out as time goes on; and if we extract even what we know to be there at the moment, and burn it, we would disastrously overload the atmosphere with carbon. He then drifts into Wonderland, and suggests that all could presently live on the present average use of energy, but in doing so he overlooks the fact that we are currently emitting, from burning fossil fuels, about two and a half times as much carbon as we should be emitting in order to allow the atmosphere to stabilize and return to a 'safe' concentration of carbon dioxide.

Looking at Smil has been something of a diversion again, but it does illustrate that Howard Hayden is not alone in failing to see the logic of where his arguments lead.

The Solar Fraud: Why Solar Energy Won't Run the World (2nd edition), by Howard C. Hayden, (2004, 280 pp) is available from Vales Lake Publishing LLC. P.O. Box 7595, Pueblo West, CO 81007-0595, $23.95 plus $10 for airmail overseas postage, $3 for surface mail).

1. Ferguson, A.R.B. 1999. *Sugarcane and Energy*. Manchester: Optimum Population Trust. 12 pp. Archived at www.members.aol.com/optjournal/sugar.doc
2. 17.5 GJ/t for dry matter is given by P. Harris (The Principles of Crop Production. In C. R. W. Spedding (ed.), *Fream's Principles of Food and Agriculture*, pp. 94-145. Oxford: Blackwell Scientific Publications) who references J.L. Monteith (1977. Climate and the efficiency of crop production in Britain. *Philosophical Transactions of the Royal Society*. London. **B.281**, 277-94).
3. Slesser, M., and C. Lewis. 1979. *Biological Energy Resources*. London: E. & F.N. Spon Ltd.
4. Smil, V. 2003. Energy at the Crossroads. Cambridge, Massachusetts: MIT press.

Appendix A

There are some points arising in Howard Hayden's text which may cause confusion, and others which may merely suggest to the reader a need for amplification. This is an attempt to deal with such, but note that minor slips and typos which are fairly easy to identify are not mentioned. Lest the reader thinks that there are rather more errors than there ought to be, I will mention that Hayden told me he continued revising his book until "fully fogged!" Moreover the slips are unimportant beside the fact that the book remains by far the best available on renewable energy — it really cuts through the nonsense! The position on the page of the following references in the 2nd edition is precisely identified by the figure after the decimal point. The page references in bold are matters which are of general relevance, rather than being of particular interest to those who are reading the book.

28.2 Hayden says, "Overall, in 2002, wind turbines in the United States produced 10.5 billion kWh, equivalent to around-the-clock average power of 1200 MWe. The wind turbine capacity was 4000 MWe, but the effect was as if the wind blew hard for 30% of the time." Wind turbines produce *some* output for about 95% of the time, nevertheless the meaning of his 30% figure is clear enough; that is to say, over the year the output of the wind turbines is 30% of what it would be were the wind turbines to produce continuously at full capacity.

That could be stated as "the load factor is 30%." However, questions arise about what is being measured. In the first edition, Hayden gave apparently similar figures for a 'load factor', but then arrived at a figure of 23.5%. Could there have been a 28% improvement in four years? It is dubious, and Hayden does not draw the distinction between infeed factor and capacity factor, yet it is important to know what is being measured. To avoid confusion, these are the meanings that I apply to terms:

Infeed factor. (IF) is the amount of electricity that is measured by a transmission system operator as having been fed into the grid, by one or more wind turbines, divided by the amount of electricity that would be produced were those turbines to operate continuously at their rated capacity. N.B. the wind turbines must be only feeding the grid, with output not being partly used in an adjacent building.

Capacity factor (CF) is a figure which is usually about 30% higher than the infeed factor, and it is the amount of electricity that is reported by wind associations, or by *Windstats*, as having been produced, by one or more wind turbines, divided by the amount of electricity that would be produced were those turbines to operate continuously at their rated capacity.[a]

Load factor (LF) is intentionally ambiguous, allowing the reader to infer from the context if the reference is to 'capacity factor' or 'infeed factor'. 'Load factor' is useful when quoting figures from a source which has failed to be precise about meaning.

Notes

a The extent to which the CF exceeds the IF has been established, with fair certainty, with data from Germany (IF 16%, CF 21%), Denmark (IF 17.5%, CF 23%) and the UK (IF 24%, CF 29%). Uncertainty still dogs the load factors emanating from the USA for which Howard Hayden (*The Solar Fraud*) reported load factors of 23.5% in 1998 and 30% in 2002. A possible explanation is that the first is an infeed factor and the second a capacity factor, but clarification is awaited.

So at present, exactly what is being measured with the Hayden's load factor of 30% is obscure (he is trying to find out).

33, Fig.15 This is the wrong Figure. The correct one is Figure 12, page 26, of the 1st edition.

67.9 "Increase of 654.57 GW over 1990." Inspection of the surrounding figures reveals that Hayden should have written 654.57 GW hours of output. However, it would seem more relevant, in the context, to mention increase in *capacity*, except that the figure has already been given in the previous line, 36.12 GW.

68.2 "Only a polished obfuscator could make an annual increase of 74,700 MWe of steady nuclear power look puny compared to 16,000 MWe of stochastic wind, solar, geothermal, wood and waste combined." The first figure is certainly wrong. The figure was given earlier as 6040 MWe increase in power *output* per year. While one cannot see data to correct the 16,000 MWe figure, it looks as though 1600 MWe might be about the right figure.

130.9 "2.708 EJ" should be "2.815 EJ".

142.8 "If availability were defined in the same way for wind turbines as for other power stations, the figure would usually equal the capacity factor." One difficulty is that it would be almost impossible to define availability in the "same way" as for normal power plants. Wind turbines in Denmark produced less than 1% of their power for 52 days in the year. Can we say that they were available during that time? Wind turbines generally produce *something* for about 95% of the time. It is hard to see any reason why 'availability' — *with any sensible and useful meaning* — is likely to be equal to capacity factor.

148.1 "The peak power density will be 3.38 kW/m^2." Obviously this should be W/m^2.

160.5 It may cause the reader to stumble when Hayden prints 160,000 kW_e when he means 160 kW_e. Apart from that slip, this paragraph could do with amplification. The paragraph is concerned with power loss in the lines connecting wind turbines. Hayden posits connecting ten wind turbine generators each of 1 MWe capacity, with transmission lines between them, each of 1 ohm resistance, using a voltage of 25 kV.

Let us first consider the electric current between #1 and #2 generators. Because watts = volts x amps (W = V x I*)*, the current will be 1,000,000 / 25,000 = 40 amps. The formula for power loss in transmission is I^2 x R, so with a 1 ohm resistance, the power loss is 1600 watts. Between #2 and #3 the current will be 80 amps, and the power loss will be 80^2 = 6400 watts, and so on, until we reach the power line *after* #10, which will be 400^2 = 160 kW_e (the number that Hayden prints as 160,000 kW_e). Hayden then gives the power lost as a rounded figure of 600,000 watts, and observes that this is 6% of the 10 MWe full capacity output of the ten turbines.

It may occur to the reader that the engineers could deal with this by using transmission lines of reduced resistance as the electric current increases; but there is a problem which is less amenable to solution that Hayden does not mention. It is that the turbines will only be operating at their capacity for a small portion of the year. On average, over the year, they will be operating at their capacity factor of say about 30%. Using the same calculation as above, the power loss then is only 0.6%, *one tenth as much*. Thus the engineers cannot design a transmission line that is ideal for both the average and the peak. It could be objected that electricity from hydro power is also intermittent, and thus the high voltage transmission lines are then only occasionally used to capacity. However hydro power is precious, in that it delivers power without delay just when it is needed. That makes it much more worthwhile to build high voltage transmission lines to carry the required current.

187.9 I feel that Hayden should have pointed out that the area given by Berman & O'Connor of 100 acres, or 40 ha, is entirely wrong. On page 190 Hayden says that the NREL give the *rated* power density as 0.5 MWe/ha. On that basis, the rated capacity of 355 MW would cover 355 / 0.5 = 710 ha, not the 40 ha indicated by Berman & O'Connor.

201.1 "Presently wind turbines…have an annual capacity factor of about 35%." As mentioned in the note to page 28, the mooted figure is 30% for the USA (the infeed factor is 16% in Germany for comparison, and the capacity factor about 21%). The meaning of what Hayden calls a 30% capacity factor requires clarification, as mentioned above.

201.7 "In the US, the total shipments of PV cells manufactured from 1982–2001 amounts to 588 *peak* MWe. Assuming an average efficiency of 10% this implies a total surface area of about 5.9 square kilometers." Hayden here makes the not uncommon mistake of confusing *rated* efficiency with the efficiency of capturing insolation. The modules, with their 588 *peak* MWe, are going to occupy the same area in any part of the world. Efficiency in the field does not come into it. What is required for this calculation is the *rated* efficiency. The *rated* efficiency of BP Solar's 'High Efficiency' silicon modules is 14.3%. That means that under the test illumination of 1000 W/m^2 the modules produce 143 watts per square meter. That is all one needs to know in order to calculate the area of module that is associated with the aforesaid 588 *peak* MWe. The area is 588 million watts divided by 143 W/m^2 = 4.1 km^2. That is of course just the module area. Normally 2:1 is allowed as a shading ratio; including that, the modules would occupy 8.2 km^2 on the ground.

To complete the picture, let's just see where the 10% fits in. It is a corollary of the *Rule of thumb* (OPTJ 4/2)[1] that the efficiency in capturing insolation in the field is 70% of the *rated* efficiency. Thus the 14% *rated* efficiency would give rise to 10% efficiency in capturing insolation. For example, in 200 W/m^2 insolation, the energy capture would be 20 W/m^2 and in 100 W/m^2 insolation it would be 10 W/m^2. To be absolutely precise, what that 10% efficiency in capturing insolation means is that with a module correctly oriented to catch as much sunlight as possible, the module will capture 10% of the insolation that would fall on a horizontal plate of the same area. That is true (within certain limits of accuracy as mentioned in the *Rule of thumb*) for all photovoltaic modules rated at 14.3% efficiency.

206.6 "Solar cells that are large enough to be useful for solar applications are about 10% efficient. Small experimental PV cells made of exotic materials have achieved much higher efficiencies, some in the range of 20%." Hayden again seems to be confusing *rated* efficiency and the efficiency of capturing insolation. The difference is important here, because the way Hayden presents matters, one might anticipate that twice as much sunshine will be captured if the *rated* efficiency is improved to 20%. That is not true. As mentioned, solar modules are produced on a large scale with a *rated* efficiency of 14.3%. If we could improve that to 20%, then we would boost the 10% of insolation that is captured to 20 x 0.70 = 14.0%, not 20%.

213.9 "The heat content of hydrogen is 140 MJ/kg. We will show on page 218 that the typical efficiency of electrolysis is 62%." I doubt that it is advisable to use the Higher Heat Value (HHV) of hydrogen. For most things it hardly matters, but for hydrogen the difference between the LHV, at 120 MJ/kg, and the HHV at 140 MJ/kg is substantial (a point that Hayden mentions elsewhere). In practice, one cannot capture the heat in the steam, so including it seems misleading to me.

Although the calculation on page 218 is valid, at least using the HHV of 140 MJ/kg, the particular electrolyser that Hayden describes is just one example. In most references, 70% is the accepted efficiency of electrolysis. What would be interesting to know is the efficiency when using the variable input from wind. I have heard, although with no details, that a problem arises there.

222.2 "The average yield of firewood in New England's abundant forests is about 0.12 W/m^2, and that 1.2 W/m^2 is considered a very high yield." Assuming that this is not a typographical error, it seems odd to suggest a factor of 10 difference, at the same location, between average yield and what is considered to be "a very high yield." I did point out the improbability of these figures to Hayden, when they appeared in the 1st edition, but he seems to have stuck with the figures and maybe he has a reason. The second figure is certainly unrealistic, at least judged by other areas of the world than New England. This is what I had to say on that subject in *Biomass and Energy*:[2]

> For instance, growing in the U.K., the annual timber increment which can be expected from Poplar is 12 m^3/ha/yr and from conifers (e.g. *Picea sitchensis*) 14 m^3/ha/yr. Allowing an expansion factor of 1.2, which is about right for these species, the total wood amounts to 14 [= 7 dry t/ha/yr] and 17 m^3/ha/yr [= 8.5 dry t/ha/yr] respectively.

For oven dry wood, a heat value of 20 GJ/t is reasonable, which gives 20 x 8.5 = 170 GJ/ha/yr = 170 / 31.5 = 5.4 kW/ha = $\underline{\underline{0.54}}$ W/m^2. Thus Hayden's average yield of 0.12 W/m^2 appears too low, and his 1.2 W/m^2 is certainly too high. 0.6 W/m^2 is probably a reasonable mean value for wood. A fairly definitely *sustainable* average yield for forest is about 3 t/ha/yr; that might be considered a lower end and it works out at 0.19 W/m^2.

222.3 "Wind ranks with biomass in terms of energy intensity, producing about 1.2 W/m^2 of land area in wind farms." Hayden's figure of 1.2 W/m^2 is about right for wind. Here is a simple check on that. In terms of watts of *rated capacity*, wind turbines are, on average, spaced to give about 4 W_e of *rated capacity* per m^2 (conversely the space needed is 25 ha per MW_e of *rated capacity*). With a 30% capacity factor, that becomes 4 x 0.30 = 1.2 W_e of *output* per m^2. So Hayden's 1.2 W/m^2 is in the ball park for wind, but his statement that this ranks with biomass is certainly misleading when stated without any qualifications. As seen above, 0.6 W/m^2 is defensible for wood, and 1.6 W/m^2 would be about right for a *maximum* yield of sugarcane, but sugarcane is a special case. What could be said is that wind produces an *electrical* output that ranks with the very best biomass yields that can be achieved in special conditions with a lot of inputs. Note, too, that if we were to use biomass, gathered at 1.2 W/m^2, to produce electricity, at say 30% efficiency, the biomass efficiency would then be 0.4 W_e/m^2. Perhaps Hayden has been led astray by his mistaken figure for sugarcane, which he gives as 3.7 W/m^2 (as listed for instance in a table on page 242), rather than 1.2 W/m^2. It is also rather misleading to even think of growing sugarcane for no other purpose than extracting heat from it. A more relevant figure might be a maximum yield of ethanol that could be extracted. The figure is 0.37 W/m^2 which, purely by chance, happens to be a tenth of Hayden's mistaken 'pure biomass' figure.

227, Figure 61 As mentioned in the main text, the correct figure for best tropical sugarcane is 1.6 W/m^2, not the 3.7 W/m^2 shown on this Figure and as given by Hayden in Table A10, page 242.

1 OPTJ 4/2, pp. 28-31. 2004. *Optimum Population Trust Journal*, Vol. 4, No 2, October 2004. Manchester (U.K.): Optimum Population Trust. 32 pp.

2 Ferguson, A.R.B. 2000. *Biomass and Energy*. Manchester: Optimum Population Trust. 28 pp. Available on the net at www.members.aol.com/optjournal/biomass.doc

ENERGY AT THE CROSSROADS, by Vaclav Smil

A Review Essay by Andrew R.B. Ferguson

It would be difficult to exaggerate the extent of Vaclav Smil's wide ranging scholarship, but even giants stumble. Smil asks the question, "What comes after fossil fuels?" On grounds which do not stand up to scrutiny, he asserts, "This question should not be asked with either regret or unease." In fact, his presentation of 'data' is likely to mislead the reader and, *contrary to his conclusions*, it appears unlikely that there are significantly useful substitutes for fossil fuels. His book does nothing to refute the necessary conclusion that humans need to start *without delay* to reduce population to a level of about 2 billion, a level many estimate as the maximum that renewable energy could support.

The list of books authored by Vaclav Smil, as published at the start of *Energy at the Crossroads*, includes seventeen titles. Seven of the titles contain a reference to energy. By way of further confirmation of Smil's pre-eminent position in the world of energy studies, the introductory pages are titled, *Reflections on a Life of Energy Studies*. In this latest book, *Energy at the Crossroads* (2004), Smil displays, yet again, his extraordinary ability to marshal data on every relevant subject.

One of his most interesting chapters is titled *Against Forecasting*. Smil provides overwhelming evidence that most energy forecasts are wildly wrong, especially those produced using computer programs. Smil does far better on the back of the proverbial envelope, but still warns against the dangers of attempting to forecast, because there are invariably discontinuities, which are impossible to prophesy. He suggests, instead, the need to lay out a wise plan for action based on current knowledge.

Despite his wisdom, there is one thing which causes this giant to stumble. He has a drive to be an optimist, which causes him to put on rose-tinted glasses when it comes to assessing the prospects for renewable energy. But first, let us look at his wisdom, which is exemplified in the opening words of the chapter on *Nonfossil Energies*:

> There is at least one obvious certainty when examining the global energy supply on the civilizational timescale: Our predominantly fossil-fueled society is bound to be a relatively ephemeral affair…
>
> Only during the past three generations (i.e., 60–70 years), or for no more than 1.5% of the civilization's time span, has humanity satisfied its varied energy needs by relying predominantly on fossil fuels. Even the combination of very large ultimately recoverable conventional fossil fuel resources, very high efficiencies of their conversion and very low energy demand of a stable global population would make it impossible to have a predominantly fossil-fueled global society lasting for more than a few hundred years. Large-scale recovery of non-conventional fuels could extend this span but only if the environmental impacts of this reliance would remain tolerable.

So far, so good, but then we have:

> What comes after fossil fuels? This question should not be asked with either regret or unease.

How does Smil manage to convince himself that there should be no cause for unease? The answer lies in those rose-tinted spectacles, supplemented by a few blind spots!

On page 240 he says, "Existing techniques allow us to convert solar radiation into electricity with power densities of 20–60 W/m^2." The truth of the matter is that just about the best source, *in terms of power density*, is photovoltaic (PV) modules. When these are oriented to catch as much sunlight as possible, they capture 10% of the insolation that would fall on a horizontal plate of the same area (OPTJ 4/2). So even if we assume the relatively high insolation pertaining to the USA (and that of sunny Spain), 200 W/m^2, this gives a power density of only 20 W/m^2. Moreover if we include the space between panels for shading, using a standard shading ratio of 2:1, the power density goes down to 10 W/m^2. Of even more importance is the fact that this power density of PV is not the worst of its problems. The chief problems with PV are (a) intermittency; (b) cost.

At 200 W/m^2, the infeed factor[1] is 14% (OPTJ 4/2) which means that with a *peak* infeed factor of perhaps 80%,[2] the PV would be doing only 14 / 80 = 18% of the work, with the DIB (dominant in-harness backup) having to cover 82%.[3] But we hardly need to bother about the arithmetic of that, as it is the cost that is crippling. Comparing wind (at a capital cost of $1 per fully installed rated watt and 24% infeed factor), with PV (at a capital cost of $5 per fully installed rated watt and 14% capacity factor), the capital cost of the PV, per unit of *output*, is more expensive by a factor of ($5 / 0.14) / ($1 / 0.24) = 9 times . Admittedly the maintenance cost of wind turbines is higher, but against that we have to set the higher inputs needed to build PV modules. So the 9 times factor is a clear pointer to the probably hopeless cost of PV, *except in a world which is rich because of the easy availability of fossil fuels* (for more details see OPTJ 4/1, pp. 18-25).

But Smil did not specify PV for the energy conversion. Is there another technique to "convert solar radiation into electricity with power densities of 20–60 W/m^2"? How about computer controlled mirrors to reflect light onto a central tower, where the concentrated sunlight heats a transfer oil called therminol? That is the *Solar Two* system as described by Howard Hayden (2004). It is situated in the Mojave desert. But that will not provide what we are looking for, because one cannot do much better for location than the Mojave desert, and Hayden gives figures (p. 187) which show that *Solar Two* only achieves a power density of 3 W/m^2.

Could Smil be referring to the 'trough' system (SEGS), built by Luz International, which uses an array of parabolic mirrors to concentrate reflected sunlight on to a black tube through which therminol flows? That falls short too, as Hayden's data (2004, p. 190) show: SEGS achieves a power density of only 11 W/m^2.

Yet SEGS really is one of the best prospects, so how has Smil managed to massage out a figure as high as 60 W/m^2? There is a clue on page 285 where he says,

> With best efficiencies and the sunniest sites troughs and towers could thus have peak power densities around 60 W/m^2 of collecting surface, in less sunny locations the densities would go down to less than 40 W/m^2. Spaces between collectors, service roads, and structures will naturally reduce those rates.

So it looks as though he has arrived at the figure he gave earlier, 60 W/m^2, by quoting a *peak* power density. That is entirely misleading. High peaks are a problem rather than something to boast about! As to *mean* power density figures, Hayden gives us the data to appraise SEGS realistically. Were we to only count the 'aperture' that the parabolic mirrors 'show' to the sun, then we could claim a mean annual power density of 33 W/m^2. But the 'shading' ratio is about 3.1 to 1 thus the land power density is the aforesaid 11 W/m^2. Shading may not be an appropriate adjective here. Probably 'access' would be better, because the high efficiency is achieved, as Hayden tells us, "by washing the mirrors every five or so days, and with a high-pressure wash every ten-to-twenty days."

But is it useful to include the spaces between collectors in making the assessment? Yes, when we consider that to produce the output of an average sized nuclear power station, say a mean 800 MW_e, would, at 11 W/m^2, require 800 / 11 = 73 km^2. Remember, too, that we are dealing in *gross* power densities. To arrive at *net* power densities we would have to account for the energy needed to produce and install the parabolic mirrors spread over 73 km^2, and the energy cost of pumping water to wash them.

Smil dons his rose-tinted spectacles again when he takes a look at wind turbines. On page 141 he states that:

> Power fluxes are at 10–50 W/m^2 for capturing tides and the kinetic energy of rivers in their upper-course, between 5–20 W/m^2 for wind, just above 1 W/m^2 for most of the lower-course hydro generation requiring large reservoirs, and below 1 W/m^2 for biomass energies.

So why is his 5–20 W/m^2 unrealistic? Let us take a typical 3 MW$_e$ Vestas wind turbine with blade diameter of 90 metres. Unless the wind is coming from a prevailing direction, and almost no one who installs wind turbines seems to think that wind can be relied upon to come from a prevailing direction, the spacing required is about ten times the blade length in both directions. Thus this wind turbine would have a *rated* power density of 3 x 10^6 / (900 x 900) = $\underline{\underline{3.7}}$ W/m^2. At a fairly typical load factor of 25%, that works out at $\underline{\underline{0.93}}$ watts of output per m^2. That's not even close to Smil's 5–20.

What is more, Vestas are sufficiently dissatisfied with the load factor that is being achieved to offer an alternative model, fitted with a generator of only 1.8 MW. This improves the load factor to about 32%, but it reduces the power density to 1.8 x 10^6 / (900 x 900) x 0.32 = $\underline{\underline{0.72}}$ watts of output per m^2.

So then how does Smil manage to produce his comforting range of 5–20 W/m^2? There is a clue on page 276, where he says:

> Rated performance of California's earlier wind projects was almost exactly 2 W/m^2 (Wilshire and Prose 1987), the Altamont Pass grouping averages about 8.4 W/m^2 (Smith 1987), and the most densely packed wind farms rate up to 15 W/m^2 (Smith 1987); in contrast, more spread-out European wind farms have power densities mostly between 5–7 W/m^2 (McGowan and Connors 2000).

Note the inherent contradiction. Smil starts with word "rated" but then finishes by talking about "power densities." It takes a perceptive reader to know that he is actually giving figures for *rated* power densities: that is the power densities that would be achieved were the wind to blow continuously at an optimum speed. In short, what he is talking about is a renewable energy Wonderland!

Even the *rated* power densities that Smil quotes are misleading. The Smith who is referenced must have searched around a lot to find a wind farm with a *rated* power density of 15 W/m^2. Let us look at the Vestas 3 MW wind turbine again, but now imagine that the design engineer is so confident that the wind will always come from the same direction that he closes up the spacing of the wind turbines, in the tip to tip direction, to 3 blade lengths. The *rated* power density then becomes 3 x 10^6 / (270 x 900) = $\underline{\underline{12}}$ W/m^2 — still not Smith's 15 W/m^2. Using Denmark's 17.5% infeed factor would yield a power density of only 2 W/m^2. So 2 W/m^2 is what may be achieved *in special cases*. In summary, Smil gives a range of 5–20 W/m^2 — thus allaying any "unease" that might trouble us — by referring to unrepresentative *rated* power densities as though they were power densities.

Smil dwells on the problem of the variability of wind, but does *not* attempt to quantify it. But quantification is essential because, as with PV, the effect is dramatic, even when the wind is relatively good. The infeed factor in Germany is 16%, and in Denmark it is 17.5%, but let us consider the more favorable 24% of the UK (which may also apply to the USA but the jury is still out on that). If we assume that the UK will have the same *peak* infeed factor as that part of Germany which E.ON Netz controls, extending for a distance of 800 km, then the *peak* infeed factor in the UK would be 80%. That means that in order to fill a 'block' of electricity using wind, the share of wind would be 24 / 80 = 30%, while the DIB would have to cover 70%. So long as fossil fuels are available, the only penalty of having to provide a DIB to compensate for the variability of wind is that of having to operate less efficient plant (or highly-efficient plant less efficiently). However, in the postulated all-renewable-energy world, the need to provide 70% from a flexible power source transforms the power density. Hydro-power is ideal, but there is only sufficient to do a small part of the required work (in the USA, there is only sufficient hydro power to allow 4% of the electricity supply to be satisfied by wind). Thus we are likely to be forced to use biomass for the DIB. Smil was in the right ballpark when assigning "below 1 W/m^2 for biomass energies." 0.6 W/m^2 is realistic. When using biomass to produce electricity, this reduces to 0.6 x 0.30 = 0.18 W_e/m^2, and that would be needed to do 70% of the work. It is evident that, when considering wind, quantification is of pre-eminent importance when estimating realistic power densities.

On page 265 Smil dwells on biomass at greater length, and says:

> Consequently, I consider the recent maximum estimates of 150-280 EJ of *additional* biomass energy available by the year 2050 (Turkenburg 2000) as utterly unrealistic. But an even much smaller extent of intensive biomass production for energy is inadvisable as it would increase the already surprisingly high human appropriation of annual terrestrial NPP [Net Primary Productivity], diminish the constantly shrinking area of ice-free land untouched by human actions, and weaken many eco-systemic services by compromising the biosphere's integrity.

Well said! In general, Smil is realistic about power densities derived from biomass, and also about producing liquids from biomass, for instance when he says (p. 269):

> Until the cellulosic phytomass can be profitably converted into ethanol the average power density (the net energy gain) of the U.S. corn-based ethanol will remain a miniscule 0.05 W/m^2 (Kheshgi, Prince, and Marland 2000).

But Smil's "until" is an *if* not a *when*, and even if the hoped for conversion of cellulosic phytomass could be made without large energy inputs, and so achieve perhaps 0.1 W/m^2 instead of 0.05, this is only capturing 5 parts in 10,000 of insolation. Yet Smil does not dwell on this, or offer a comparison to show, for instance, that producing synthetic gasoline from coal equates to capturing 2000 parts per 10,000. Furthermore, he confines his thoughts on how to produce hydrogen from renewable sources to this conditional clause (p. 306): "If we were to assume that inexpensive electricity from renewable sources will be available in large amounts within 20 years, allowing us to electrolyze water by using indirect solar flows rather than by burning fossil fuels, that welcome advance would not translate immediately into a hydrogen-dominated world." *But what about not assuming that "welcome advance"*? Smil remains silent. Even if everything Smil said about other renewable energy sources were to be the unvarnished truth, the liquid energy problem alone should have led him to avoid giving the answer that he gave to his rhetorical question:

> What comes after fossil fuels?
> This question should not be asked with either regret or unease.

So if Smil is wrong, then what is the reality? It is that there is no scientific evidence to underpin this misconstrued hypothesis: *renewable energy sources can replace fossil fuels to the extent of supporting the present world population*. The necessary conclusion is that humans need to start *without delay* to reduce their population to a level that would be sustainable without fossil fuels. We, in OPT, share the view of many who have estimated what that number is likely to be: the figure is "not much higher than 2 billion."[4]

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Endnotes

1. **Definitions**

   Infeed factor. (IF) is the amount of electricity that is measured by a transmission system operator as having been fed into the grid, by one or more wind turbines, divided by the amount of electricity that would be produced were those turbines to operate continuously at their rated capacity. N.B. the wind turbines must be only feeding the grid, with output not being partly used in an adjacent building.

   Capacity factor (CF) is a figure which is usually about 30% higher than the infeed factor, and it is the amount of electricity that is reported by wind associations, or by *Windstats*, as having been produced, by one or more wind turbines, divided by the amount of electricity that would be produced were those turbines to operate continuously at their rated capacity.[a]

   Load factor (LF) is intentionally ambiguous, allowing the reader to infer from the context if the reference is to 'capacity factor' or 'infeed factor'. 'Load factor' is useful when quoting figures from a source which has failed to be precise about meaning.

   Note

   a. The extent to which the CF exceeds the IF has been established, with fair certainty, with data from Germany (IF 16%, CF 21%), Denmark (IF 17.5%, CF 23%) and the UK (IF 24%, CF 29%). Uncertainty still dogs the load factors emanating from the USA for which Howard Hayden (*The Solar Fraud*) reported load factors of 23.5% in 1998 and 30% in 2002. A possible explanation is that the first is an infeed factor and the second a capacity factor, but clarification is awaited.

2. The *peak* infeed factor of a small group of PV modules would be 100%, but spread sufficiently widely the *peak* could be reduced. The 80% value is merely a guesstimate..

3. The concept of a DIB (dominant in-harness backup) is slightly less applicable to PV than it is to wind, because PV fairly regularly produces its output in the middle of the day, and thus the increase in output will sometimes do no more than allow flexible inputs to be increased less than they would be otherwise. However, it must be rare to get a perfect match between changing PV input and changing demand.

4. In their superb book, *Food, Energy, and Society*, the Pimentels gave a figure of about 2 billion (Pimentel and Pimentel, 1996:xvi). Dr Paul Ehrlich mentions that "we and others" (Ehrlich et al., 1998:112) estimate a global figure of around 1.5 to 2 billion for maintaining a European lifestyle. Any figures are of course highly dependent on the lifestyle which is assumed. The top figure of 3 billion is broadly compatible with the conclusions reached in OPT's *World Carrying Capacity: an interim report* (Ferguson, 2000). There it is concluded that 1.5 billion could live at a modest European lifestyle, while taking note of about another 2 billion who remain largely untouched by modern technology. Fleay (1995) suggests that, "The world may only be able to support a population of 3 billion without this [fossil fuel] input."

THE COLLAPSING BUBBLE, by Lindsey Grant

reviewed by Andrew R.B. Ferguson

The South Sea Bubble and the 'dot com' bubble are but two examples of a recurrent phenomenon in human affairs. Humans create bubbles of fantasy which cause pain when they collapse. Lindsey Grant, in his most recent book, *The Collapsing Bubble*,[1] looks at the 'fossil fuel bubble'. It is of a different order of importance. Facilitated by fossil fuels, the bubble growth in human population during the past two centuries has been a period of weak restraints on growth (a WROG period).[2] The collapse of the bubble, as fossil fuels become increasingly scarce, will happen during this century.

The book is thus addressing the most important issue facing humanity today. Howard Hayden's *The Solar Fraud* (see p. 3), and Vaclav Smil's *Energy at the Crossroads* (p. 9), were attempting something similar, but *The Collapsing Bubble* is singular because the author recognizes the logical conclusion of his analysis, namely that without fossil fuels human population must be much smaller. What is more, Grant achieves his exposition in a mere 74 pages. If, as I tend to think, a book is important in direct proportion to what it has to say, and in inverse proportion to its length, then this little book deserves comparison to Clive Ponting's *A Green History of the World*.

Grant is also to be commended for seeing that nowhere is it more appropriate to take immediate action than in the United States. The front cover of the book shows Figure 1, *U.S. Energy Use & Population*. The figure is described, on page 22, as a "stacked graph showing the history of U.S. conventional energy consumption and a speculative projection of its likely path this century, based on current trends and assuming no fundamental policy changes (such as those I advocate);" it also shows the projected size of U.S. population in 2100 according to the Census Bureau middle projection, 600 million. Grant observes that this middle projection is 100 million more than the Bureau's middle projection in 1994. Further upward revisions may soon be needed. U.S. population was about 294 million in 2004. If U.S. population continues to grow at the rate of the three closing decades of the last century, 1.06% per year, then by 2100 U.S. population would be 810 million.

I mention that partly as an illustration of the fact that Grant presents a balanced view. He does not overstate his argument by using the most alarming figures. He even succeeds in plotting a median path in the most difficult field, where the 'experts' rarely agree, namely renewable energy. Neither does he allow himself to get lost in detail, but keeps in sight the essence of what is really important. It is summed up in this extract (p. 23):

> Our political and business 'leaders' seem generally oblivious to the unique character of the fossil fuel age. They consider growth the natural and desirable order of affairs and call for more of it — an outlook influenced more by greed than reflection. When warned of the brevity of the fossil era and the dangers it is creating, they defend the status quo or, when pressed, offer simplistic panaceas such as the hope that hydrogen or wind and solar energy will solve our problems. By themselves, they will not.

The argument is well supported with numbers when appropriate. Overall, it is hard to see that the vital issues could have been presented better than is achieved in this little book.

1. *The Collapsing Bubble*: *Growth and Fossil Energy*, by Lindsey Grant. 2005. Seven Locks Press, P.O. Box 25689, Santa Ana, CA 92799. Tel: (800) 354-5348. sevenlocks@aol.com US$9.95.
2. Stanton, W.I. 2003. *The Rapid Growth of Human Populations 1750 — 2000: Histories, Consequences, Issues, Nation by Nation.* Multi-Science Publishing Company Ltd, ISBN 0 906522 21 8; published September 2003, 230 pp.

This piece first appeared in OPT's in house magazine *Jackdaw*, but I am sure that it is of wider interest. Moreover it fits in perfectly with a major theme of this issue, namely that the chief battle of all those who would save the human race from unmitigated disaster is against that pernicious tendency to delusion, which historically is exemplified by all sorts of curious religious beliefs, the Crusades, and a belief in witchcraft.

GOD BLESS AMERICA

by Edmund Davey, 68 Croxall Road, Edindale, Staffordshire, B79 9JE

On the Radio 4 *Today* programme during the week ending Friday January 7th, listeners were invited to email a proposition starting with: "I believe, though I have no way of proving, that…" Religious beliefs are of that nature; and some religious beliefs may be considered the very opposite of benign. What would you think of the idea that protecting natural resources is unimportant in the light of the imminent return of Jesus Christ?

There is a murky tangle of American political connections which supports that viewpoint. In *Rolling Stone Magazine,* Robert F Kennedy Jnr. (prosecutor for the National Resources Defence Council) says:

> In 1980, candidate Ronald Reagan declared, "I am a Sagebrush Rebel," marking a major turning point of the modern anti-environmental movement. In the early 1980s, the Western extractive industries, led by one of Colorado's worst polluters, brewer Joseph Coors, organized the Sagebrush Rebellion, a coalition of industry money and right-wing ideologues that helped elect Reagan president. The big polluters who started the Sagebrush Rebellion were successful because they managed to broaden their constituency with anti-regulatory, anti-labor and anti-environmental rhetoric that had great appeal …among Christian fundamentalist leaders such as Jerry Falwell and Pat Robertson, …[1]

Pat Robertson's name has cropped up consistently as one with political leverage through his long-standing relationship with Michael Ledeen—"at least to the early 1980's"—according to Katherine Yurica in a website article.[2] Yurica points out that Ledeen's ideas are promulgated by such influential figures as Richard Cheney, Donald Rumsfeld and Paul Wolfowitz, and says he is: "…the only full-time international affairs analyst consulted by Karl Rove, President Bush's political advisor."

Glenn Scherer, writing in *Grist* magazine, tells us:

> In 1981, President Reagan's first secretary of the interior, James Watt, told the U.S. Congress: "God gave us these things to use. After the last tree is felled, Christ will come back," in a public testimony that helped get him fired. .[3]

Scherer continues:

> Today's Christian fundamentalist politicians are more politically savvy … but their words and actions suggest that many share Watt's beliefs. Like him, many Christian fundamentalists feel that concern for the future of our planet is irrelevant, because it *has* no future. They believe we are living in the End Time, when the son of God will return, the righteous will enter heaven, and sinners will be condemned to eternal

> hellfire. They may also believe, along with millions of other Christian fundamentalists, that environmental destruction is not only to be disregarded but actually welcomed—even hastened—as a sign of the coming Apocalypse. We are not talking about a handful of fringe lawmakers who hold or are beholden to these beliefs. The 231 legislators (all but five of them Republicans) who received an average 80 percent approval rating or higher from the leading religious-right organizations make up more than 40 percent of the U.S. Congress.
>
> And those politicians are just the powerful tip of the iceberg. A 2002 *Time*/CNN poll found that 59 percent of Americans believe that the prophecies found in the Book of Revelation are going to come true. Nearly one-quarter think the Bible predicted the 9/11 attacks.

Pointing out that: “Many End-Timers believe that *until Jesus' return*, [my italics] the Lord will provide”, Scherer quotes *America's Providential History,* “a popular reconstructionist high-school history textbook,” in which authors Mark Beliles and Stephen McDowell opine: “The secular or socialist has a limited resource mentality and views the world as a pie ... that needs to be cut up so everyone can get a piece.” However, “the Christian knows that the potential in God is unlimited and that there is no shortage of resources in God's Earth. The resources are waiting to be tapped.” In another passage, the writers explain:

> While many secularists view the world as overpopulated, Christians know that God has made the earth sufficiently large with plenty of resources to accommodate all of the people.

Mixed messages? No need to care for the environment, because God will provide; but if we wreck His creation, he’ll come and bale us out anyway (the righteous, that is).

At the beginning of chapter 1 of *America’s Providential History* (entitled *God’s Plan for the Nations*) are the words:

> The goal [of this book] is to equip Christians to be able to introduce Biblical principles into the public affairs of America and every nation of the world...we will be learning how to establish a Biblical form (and power) of government in America…the principles we will be learning…will be able to be applied throughout the world and not just in America. As we learn to operate nations on Biblical principles, we will be bringing liberty to the nations of the world and hence fulfilling part of God’s plan for the nations.”[4]

Scherer again:

> To understand how the Christian right worldview is shaping and even fuelling congressional anti-environmentalism, consider two influential born-again lawmakers: House Majority Leader Tom DeLay (Texas, Republican) and Senate [member]… James Inhofe (Oklahoma, Republican)… Neither DeLay nor Inhofe include environmental protection in “the Lord's work.” Both have ranted against the EPA, [Environmental Protection Agency] calling it “the Gestapo.” DeLay has fought to gut

> the Clean Air and Endangered Species acts. Last year, Inhofe invited a stacked-deck of fossil fuel-funded climate-change sceptics to testify at a Senate hearing that climaxed with him calling global warming "the greatest hoax ever perpetrated on the American people."
>
> DeLay has said bluntly that he intends to smite the "socialist" worldview of "secular humanists," whom, he argues, control the U.S. political system, media, public schools, and universities. He called the 2000 presidential election an apocalyptic "battle for souls," a fight to the death against the forces of liberalism, feminism, and environmentalism that are corrupting America. The utopian dreams of such movements are doomed, argues the majority leader, because they do not stem from God. …
>
> James Inhofe might be an environmentalist's worst nightmare. The Oklahoma senator makes major policy decisions based on heavy corporate and theological influences, flawed science, and probably an apocalyptic worldview—and he chairs the Senate Environment and Public Works Committee.

Another commentator, Bill Moyers, observes:

> One of the biggest changes in politics in my lifetime is that the delusional is no longer marginal. It has come in from the fringe, to sit in the seat of power in the Oval Office and in Congress. For the first time in our history, ideology and theology hold a monopoly of power in Washington. Theology asserts propositions that cannot be proven true; ideologues hold stoutly to a world view despite being contradicted by what is generally accepted as reality… When ideology and theology couple, their offspring are not always bad, but they are always blind. And there is the danger: voters and politicians alike, oblivious to the facts.[5]

In an article in The International Herald Tribune on January 11th, John Vinocur finds much evidence to suggest that President Bush in his second term is diluting his adherence to crusading neoconservatism with a hefty addition of political pragmatism. Dare we hope that this shift might encompass the environment, so harshly treated in his first term, when the heralds of the apocalypse were so firmly planted at his shoulder?

Endnotes

1. Robert F. Kennedy Jr: 'Crimes Against Nature', Rolling Stone Magazine; www.rollingstone.com
2. 'The Despoiling of America: How George W. Bush became the head of the new American Dominionist Church/State;' The Yurica Report: www.yuricareport.com Nov 2004
3. 'The Godly Must Be Crazy;' Glenn Scherer, writing in Grist Magazine, www.grist.org 27th Oct 2004.
4. America's Providential History; Mark Beliles and Stephen McDowell.
5. Bill Moyers, speaking On Wednesday, December 1, 2004, at Harvard Medical School, as he received its fourth annual Global Environment Citizen Award.

THE DEPTH OF DELUSION

by Andrew R.B. Ferguson

Media Lens is an admirable organization, which aims to point out the extent to which the mainstream media are so imbued with unconscious prejudices that what passes for reporting serves largely to mislead. But Media Lens itself, in the course of investigating shortcomings in relation to carbon dioxide emissions, fails to appreciate the essential point, which is that even the solution which is touted as the right solution is no solution at all without reducing world population to about 2000 million.

Readers of the OPT Journal will be aware of the fact that the human race is prone to be led into delusion (Mackay 1841; Crawshay-Williams 1947); and perhaps also that the media play a substantial part in nurturing delusions. The present paper illustrates the depth of delusion which exists on one subject, namely the action needed to reduce carbon dioxide emissions to a tolerable level. It does so mainly by using data collected by an admirable organization called Media Lens <http://www.medialens.org>.

What is obvious to anyone whose thinking is not distorted by an unconscious drive for a comforting delusion is that goals for the reduction of carbon dioxide emissions need to take into account the differences in per capita emissions between nations. For instance, the annual carbon dioxide emissions of the USA were (1996 figures) about 20 t/cap, while the figure was 10 t/cap for Europe. On the other hand China, at the same time, was emitting 3 t/cap, and India 1 t/cap (Engelman et al. 2000). Obviously there is a need for the USA and Europe to decrease their emissions to get somewhere near the world average figure of 4 t/cap/yr. It is obvious, too, that China and India will need to increase their emissions to at least the world average. That is just a first cut at the problem. It suffices to show that it is nonsense to suppose that every nation should make the same adjustments. The starting position of each is paramount. Let us study an equitable solution in more detail.

There is certainly room for discussion about the extent to which harsh climatic conditions should allow deviation from allocation by simple division — although that idea has not been included in the only plan put forward so far for an equitable solution, namely "Contraction and Convergence." The phrase is apt, insofar as it indicates that most nations need to *contract* their emissions so that, at some time in the future, all nations *converge* on an appropriate per capita emission figure. However, those who advocate Contraction and Convergence have not asked themselves whether it has the slightest chance of being a solution *without being accompanied by a dramatic contraction of population*. Clearly, when we look at the arithmetic, it has no chance at all.

Let us start by simply dividing the necessary goal of 9000 million tonnes of carbon dioxide a year (Engelman 1994 p. 27; OPTJ 3/2 pp. 28-31) by the present world population of about 6500 million. That would allow 1.4 t/CO_2/yr. But mean world emissions today are about 4 t/CO_2/yr, and we well know that many people are spending a large part of their day collecting firewood, or dung, to burn, and some people are still going cold in winter, so obviously 1.4 t/CO_2/yr would not support the sort of life that most people would regard as acceptable. Indeed, it would not keep people alive in the northern parts of the USA or Russia. Based on Smil's careful analysis (Smil 2003, p. 352), we know that about 4 t/CO_2/yr (which allows an energy consumption of about 2 kW) is a minimum *average* emission to allow an adequate standard of living. That means that the Contraction and Convergence policy only makes sense if there is also to be a contraction in population to about 9000 / 4 = 2000 million (a round 2000 million, as it makes little sense to try to be more accurate than the nearest half billion).

Having taken a look at a sane policy which might work, namely one which includes both contraction and convergence *and reduction in population*, we can now proceed to observe the extent to which there are signs of delusion in those who write articles on the subject. Let us note that freedom from delusion requires at least a discussion of (a) a fair way of distributing emission rights (the only proposal on the table for this so far is Contraction and Convergence); (b) recognition that Contraction and Convergence could not possibly provide a solution by itself, and what is also required is a reduction in world population to 2000 million. Before commenting further on item (b), let us see what Media Lens discovered in its analysis of the articles written in UK national newspapers. These are the words of Media Lens in an Alert dated 1 March 2005.

We conducted a Lexis-Nexis newspaper database search to gauge the relative importance given to different topics in climate news reports by a number of major environment reporters. The following figures relate to the five year period leading up to, and including, 25 February 2005. We investigated to what extent equity, and contraction and convergence, entered into mainstream news reports on climate, in the best British press.

Michael McCarthy (Independent) Number of news reports
"climate" 232
"climate" + "industry" 80
"climate" + "Blair" 53
"climate" + "equity" 0
"climate" + "contraction and convergence" 0

Geoffrey Lean (Independent on Sunday)
"climate" 105
"climate" + "industry" 40
"climate" + "Blair" 38
"climate" + "equity" 0
"climate" + "contraction and convergence" 1

Charles Clover (Telegraph)
"climate" 136
"climate" + "industry" 47
"climate" + "Blair" 38
"climate" + "equity" 0
"climate" + "contraction and convergence" 0

Paul Brown (Guardian)
"climate" 287
"climate" + "industry" 137
"climate" + "Blair" 48
"climate" + "equity" 1
"climate" + "contraction and convergence" 1

John Vidal (Guardian)
"climate" 193
"climate" + "industry" 98
"climate" + "Blair" 31
"climate" + "equity" 1
"climate" + "contraction and convergence" 0

This is not a rigorous scientific analysis, of course, but the numbers are highly indicative of hugely skewed priorities. Out of a grand total of 953 articles across the *Independent*, *Independent on Sunday*, *Guardian* and *Telegraph*, C&C was mentioned only twice, as was equity. On the other hand, industry was addressed in 402 articles, and Blair was mentioned 208 times, both almost entirely from an uncritical perspective.

What we learn thereby is that the newspapers are just as bad as *Worldwatch*, *The Ecologist*, environmental organizations such as *Friends of the Earth* and *Greenpeace*, and *New Scientist*, to mention just a few. In fact *New Scientist* did once indicate, in an editorial, that contraction and convergence was the only policy that could be regarded as equitable, but otherwise the journal has been as assiduous as the newspapers in avoiding discussion of equitable and effective pathways to adequately reduce emissions.

The title of the present article is the "*Depth* of Delusion." That is justified in part by consideration of the fact that Media Lens, which is doing its best to point out the shortcomings of the media, itself fails to realize that Contraction and Convergence cannot work without a reduction of population to about 2000 million. In other words, even those trying to correct delusion are themselves deluded!

It is also justified because Emeritus Professor Howard Hayden, in his book *The Solar Fraud: Why Solar Energy Won't Run the World*, fails to consider the obvious question, namely whether solar energy might run a world of 2000 million.

It is further justified by the fact that Distinguished Professor Vaclav Smil can entirely overlook the problem of overload of carbon dioxide when he soothes his readers with this misleading observation (Smil 2003, p. 354):

> The enormous global inequity that has been put in place by the economic development of the last two centuries cannot be undone in a generation but these simple yet factually unassailable comparisons demonstrate that an impressively high quality of life could be enjoyed worldwide with virtually unchanged global energy consumption.

What Smil leaves entirely unsaid, within that context at least, is that present global energy consumption is resulting in emissions which are about two and a half times as much as they need to be to achieve stabilization of carbon dioxide at a tolerable level.

It appears that appreciation of reality is perceived by a very small percentage of the human race, so the title should arguably have been the "Depth and Breadth of Delusion," but the shorter title serves well enough as a reminder of the general problem.

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"WEB OF DECEIT" by Mark Curtis

with some introductory thoughts by Andrew Ferguson

The July 2004 newsletter of *Scientists for Global Responsibility* contained a warm review of the book *Web of Deceit* by Mark Curtis.[1] Noam Chomsky, in his review of it, said that the author, "scrupulously, relentlessly…rescues the historical and documentary record from a web of distortion and self-serving illusion." That summary could hardly be more apt or concise. Since the subtitle of the book is "*Britain's Real Role in the World*," it is clear that the book is essentially political. So what relevance does it have to OPT and population issues? The answer to that question becomes apparent when we recall how often in the pages of the OPT Journal reference is made to the books, *The Comforts of Unreason: A Study of the Motives behind Irrational Thought*, by Rupert Crawshay-Williams, and *Extraordinary Popular Delusions and the Madness of Crowds*, by Charles Mackay.

Delusion is at the root of much human behaviour, but even with the advantage of historical perspective it is hard to sort out where deceit ends and self-serving illusion starts. It seems likely that the Crusades that were encouraged by popes in the 14th century, and the centuries of witch-hunting inaugurated by Pope Innocent VIII in 1488, emanated from a mixture of these two human traits. It is therefore hardly surprising that, with respect to current problems such as global warming, global poverty, globalisation, and excessive population, the task of separating deceit from self-serving illusion is extraordinarily difficult. In many cases, we can have no doubt that nations are pursuing their own short term interests — discounting the likely damage to other nations and future generations — and that both factors are at work. But in what proportions? Perhaps we may instruct ourselves in these matters by taking a look at *Web of Deceit*, and learn to judge better where self-serving illusion ends and deceit begins. If that task is hard in political matters, it is likely to be harder in matters of population and renewable energy, because belief in the value of human life, irrespective of circumstances, has very deep roots. So deep that every bit of evidence to the contrary is likely to be ignored if it appears to threaten the desired belief. With that introduction, we can let Mark Curtis speak for himself, noting particularly the quotation from page 214, which draws specific attention to the fact that self-serving illusion may be the explanation, rather than deceit, and similarly the one from page 356.

p. 207 The official story is that British policies are helping to make globalisation work for the poor and to eradicate poverty globally, while supporting democratic groups and governments. The reality, however, is quite different.

Under New Labour Britain is helping to organise the global economy to benefit a transnational business elite while pursuing policies that are often deepening poverty and inequality. New Labour has, in fact, a very grandiose project, not — as it claims — simply to *manage* globalisation, but actively to push an extreme form of economic 'liberalisation' globally.

The Blair government is also continuing the British tradition of undermining countries' ability to pursue *independent* development strategies which might be successful. It is basing its foreign policy on propping up many repressive elites, especially in the Middle East, while undermining many democratic, popular forces. The reality is that the British government regularly views democracy abroad as a threat — which matches how it increasingly sees the public in Britain. These policies are being decided in an elitist and increasingly undemocratic decision-making process in Britain, which in its foreign policy is, I argue, akin to a totalitarian state.

These policies are harming people all over the world. Even though this is hard to miss — and is shown in the following five chapters — it is largely being missed, because most commentators in a position to see have willingly swallowed New Labour's extraordinary rhetoric. I believe that the Blair government's world view is actually very frightening.

p. 214 The great change brought about by New Labour is that an extremist economic project is being pursued under a great moral pretext — that global 'liberalisation' will promote 'development' and 'poverty eradication'. This is not a government conspiracy to mislead the world — the new liberalisation theologists actually appear to believe it.

p. 243 Popular democratic forces are more of a threat than a promise to British governments. It is a myth that British governments generally promote democracy abroad. The reality is quite the opposite. Britain tends to support any government that promotes its fundamental interests, which are to maximise its political influence in the world and make the global economy enrich British and commercial interests. Given that many popular, nationalist and/or democratic forces oppose these aims, Britain systematically sides with elites, often repressive ones who will keep such democratic forces in check.

p. 248 In the early postwar period, the West propped up a series of straightforwardly repressive elites who did its bidding — dictators such as Mobutu in Zaire, Suharto in Indonesia, the Shah in Iran, and so on. These authoritarian regimes provided the crucial 'favorable investment climates' for Western business. Support of repressive regimes — especially in the Middle East and Gulf — remains a cornerstone of British and Western foreign policy, and is deepening under the 'war against terrorism'.

p. 254 British policy in the Middle East is based on propping up repressive elites that support the West's business and military interests. This is having two outcomes. The first is that Britain is often undermining the prospects for the emergence of more popular and democratic governments. The second is that it is helping to fan the flames of religious extremism as often the only alternative available to those being repressed. Britain's role in the region is far from benign and is, frankly, dangerous to its inhabitants as well as — perhaps increasingly — people in Britain and the West. These are truisms about all British governments, but New Labour is continuing the policy, indeed with real enthusiasm.

p. 346 When it comes to US interventions in Latin America, a clear pattern is visible: a popular government comes into power with an agenda of addressing poverty and inequality; these priorities threaten the control of resources by US businesses; the government is deemed an agent of international communism; and the US sends troops, or covertly engineers a change in government to restore 'order' and 'security'. This was the essential course of events in Guatemala (1954), Brazil (1964), the Dominican Republic (1965) and Nicaragua (1980s).

But the precedent for this pattern in Latin America was not set by the US, but by Britain.

p. 356 Horrible British foreign policies are routinely either ignored (virtually) completely in mainstream media and academia, or reported but given ideological treatment that conforms to elite priorities.…It is not a conspiracy; rather it works by journalists and academics *internalising* values, accepted wisdom and styles of reporting.

1. Mark Curtis. *Web of Deceit: Britain's Real Role in the World*. 2003. London, UK (also Australia, New Zealand, South Africa): Vintage. £8.

This piece first appeared in the August 2003 issue of the OPT in-house magazine, *Jackdaw*. But it may deserve a wider airing, especially as the human tendency to delusion is not only a major theme of this issue of the *OPT Journal*, but it also probably constitutes about nine-tenths of the difficulty of doing anything about the problems which Herman Daly, Lindsey Grant, David Pimentel Clive Ponting and Walter Youngquist, to name just a few wise men, have expressed with perfect clarity over many years. Anyhow, it is always nice to be able to see a ray of light at the end of the tunnel, and that is another reason for repeating this piece.

THE ROOTS OF DELUSION: A QUEST

by Andrew R.B. Ferguson

Those who wish to appraise the human tendency to self-delusion will find the following books very helpful: (a) *Extraordinary Popular Delusions and the Madness of Crowds* by Charles Mackay (1841); and (b) *The Comforts of Unreason* by Rupert Crawshay-Williams (1947). However, it is one thing to be aware of the problem, but quite another to know what to do about it. Especially because the situation may be every bit as bad as Crawshay-Williams suggests in the epilogue to his book:

> Whether or not I have made out a reasonable case for the views expressed in this book, I leave the reader to judge, confident that — if I am right — his opinions will probably remain unchanged whatever anyone says.

While it would be hard to exaggerate the pervasiveness of this 'delusional' problem, a ray of hope is appearing, thanks to progress in neuroscience. This was reported by Vilinor Ramachandran, of the Neurosciences Institute in California, during the course of the 2003 BBC Reith lectures, which Ramachandran titled *The Emerging Mind*. He concluded his fifth, and last, lecture with these words:

> I hope that I have succeeded in conveying to you the sense of excitement that my colleagues and I experience each time we try to tackle one of these problems that we have been talking about: hysteria, phantom limbs, free will, the meaning of art, denial or neglect, or any one of the syndromes that we have talked about in earlier lectures. Second, I hope that I have convinced you that by studying these strange cases, and asking the right questions, we neuroscientists can begin to answer some of those lofty questions that thinking people have been preoccupied with since the dawn of history. What is free will? What is body image? What is the self? Who am I? Questions that until recently were the province of philosophy.
>
> No enterprise is more vital to the well being and survival of the human race. This is just as true now as it was in the past. Remember that politics, colonialism, imperialism, and war also originate in the human brain.

We must agree that neuroscience is important, but can it be applied to the 'delusional' problem? Ramachandran showed us the extent of the progress that has been made in studying the brain using PET (Positron Electron Tomography) scans, and NMR (Nuclear Magnetic Resonance) scans.

For instance, he recounted the case of a man whose vision was largely normal, who therefore had no problem in recognizing that when his mother stood before him, she did indeed look exactly like his mother, yet he declared that she was an impostor. The patient insisted that while this person looked like his mother, it was actually someone else who was trying to deceive him. From brain scans, it was clear that the usual messages which are sent from the optical processors to the emotional centres had become inoperative. Thus while normal people would experience an emotion when they see their mother, this patient experienced no more emotion than he would when looking at a table or chair. The only reason that the patient could conjure up to explain this strange fact was that the woman he was looking at was an impostor!

That case mainly demonstrates how precisely we can see what is going on in the brain. What is of more relevance to the 'delusional' problem, which we are considering here, is the case of patients who suffer from hysteria in the medical sense. Hysteria, in the medical sense, refers to the situation in which a brain scan shows that there are no lesions in the brain, and that the muscles are in good order, yet a patient reports that a limb is paralysed. Doctors have, for a long time, explained this problem as being psychological. They were right. Moreover now, with the benefit of brain scans, we can understand the problem more precisely.

When a person wants to move a limb, the brain 'lights up' in a pre-motor area, moments before the motor area actually moves the limb (contemporaneously with which one becomes conscious of the intention to move the limb). When a hysteric patient attempts to move the 'paralysed' limb, the pre-motor area still lights up, showing that he or she *really* is trying to move the limb. In other words, he or she is not just saying they are trying; they really are trying. But then something odd happens. Other areas of the brain linked to the emotional centres light up, and cancel out the signals from the pre-motor area, so that the motor area never gets to operate. Moreover, the same brain pattern occurs with patients who have been hypnotised and told that they will not be able to move some limb.

While it is going beyond the experiments that Ramachandran reported, it seems a reasonable supposition that something similar is likely to be going on when people with a logical capacity refuse to see the logic of something that runs contrary to what they wish to believe. The alternative, to what might perhaps appropriately be called the 'active inhibition hypothesis', is that the logical faculty simply becomes inoperative whenever the subject under discussion is one on which a person has pre-conceived opinions. That too might tell us something important, but I suggest that the first hypothesis, the 'active inhibition hypothesis', appears to be the more plausible. If that is so, the inhibition areas — which most likely will again prove to emanate from the emotional centres — would only light up when discussing something about which the subject had strong opinions which he or she was unwilling to alter, for only such subjects would produce an emotional need to paralyse their logical faculties.

Without going into all the details of how the relationship would need to be established in the first place, except to observe that rabid 'creationists' could prove very useful, once the truth of the hypothesis had been established, it would be easy to test someone, because it would not be necessary to know what was the right answer to the question being put. For if, when considering matters in which logical thought is clearly required, the person under investigation was consistently showing activity in the areas of the brain which cancel out their logical faculties, then that person is clearly incapable of making sound judgements in that area.

Were this advance in neuroscience to be made, there would be an easy way of weeding out those politicians, economists and media gurus who continue to hold obviously fatuous views. Their brains would be lighting up like Christmas trees a great deal of the time, as various parts of their brains sprung into action to cancel out their logical faculties!

It might be a slow process, because first the voters would have to be brought to see the importance of not being led by deluded politicians, and thus insist that politicians must be tested before being accepted as possible candidates. Only when that step had been taken, with time allowed for it to take full effect, can one imagine that politicians would see the need to weed out deluded economists (i.e. 95% of them) and media gurus. It has to be admitted that the prospects of complete success in this project cannot be rated as high. Yet the danger of continuing along our path of delusion is so great, that anyone who is in a position to influence the focus of neuroscientists' activities should do all they can to encourage them to focus their attention on proving or disproving the 'active inhibition hypothesis'.

It should not be hard to be persuasive, for it is patently obvious that the general run of politicians, economists and media gurus, are so deluded that they are able to believe that: (a) globalization is good; (b) perpetual expansion is not only good but essential; (c) that when fossil fuels are exhausted, renewable energy can easily replace them; and (d) that there are no dangers for the Earth's ecological system in attempting to accommodate the present 6 billion humans. Nevertheless, one would have to choose with some care which neuroscientists to approach, because there must be a few of them who suffer from similar delusions to politicians, economists and media gurus, and therefore would be unable to see the urgency of making progress regarding the 'active inhibition hypothesis'.

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ASSESSING THE MILLENNIUM ASSESSMENT

by Andrew R.B. Ferguson

Abstract: The *Millennium Ecosystem Assessment* (MA) *Synthesis Report* failed to assess the *implications* of the ecosystemic changes that are resulting from excessive human pressure on the environment. This is a pity, since the authority of the 1300 scientists would have given additional publicity to the fundamental nature of the problem — an excessive number of humans — which is already well understood by a few scientists.

According to the report in *New Scientist*, 2nd April 2005, the *Millennium Ecosystem Assessment* (MA) *Synthesis Report* cost $24 million and took more than 1300 'experts' (as the press release describes them), in 95 countries, four years to put together. It thus behoves us to assess whether that collective effort has been able to see the wood for the trees. A collective report representing 1300 experts suffers from the problem of having to draw conclusions that 1300 experts can sign off to. Since irrational beliefs are inevitable on the taboo subject of population, that mightily circumscribes what the report can say. How circumscribed, we will attempt to investigate.

The assessment being made here will be based only on the report of the MA as found in *New Scientist*, plus a two page press release dated 30 March 2005 sent to me by Edmund Davey, campaign secretary of OPT. Doubtless the full report contains more detail, but as the aim here is to deal with the salient points, the additional information contained therein need not overmuch concern us.

Let us start by looking at one 'wood' that the MA should have been able to see, namely the carbon dioxide problem. From burning fossil fuels, the world is emitting about 6800 million tonnes of carbon per year in the form of 25,000 million tonnes of carbon dioxide. Moreover, as established in *Perceiving the Population Bomb*,[1] in order for people to have a moderately comfortable life there is a requirement for an average release per person of 4 tonnes of carbon dioxide per year. As established by the IPCC, and dealt with at some length in *The Crucial Limit*[2], to stabilize carbon in the atmosphere at a safe level, carbon dioxide emissions from burning fossil fuels need to be reduced to 9000 million tonnes a year. Thus population needs to be reduced to 9000 / 4, say about 2000 million. According to the two aforementioned reports of the MA's findings, the 1300 experts were unable to see that particular 'wood'. Doubtless some of them did, but their insight was screened out to arrive at a consensus.

The only likely way to escape from this compelling need to reduce population — arising from the need to contain carbon dioxide emissions — would be to produce most of the energy needed (2 kW per person) from renewable resources. This is another 'wood' that the MA should have been able to see, namely the pre-eminent importance of establishing what is likely to be possible with respect to achieving a useful power density from renewable resources. Doubtless there were again some scientists who were able to see that picture with fair clarity, but it is hardly surprising that the MA did not attempt an assessment, since it is a subject on which extraordinary errors are still being aired, as in Vaclav Smil's recent book *Energy at the Crossroads*.[3] A book which understands the matter rather better is Howard Hayden's *Solar Fraud: Why Solar Energy Won't Run the World*,[4] but it has yet to be properly absorbed by the academic world, making the chances of achieving consensus among 1300 experts close to zero.

While the MA has thus missed out on the two most important questions, it has filled in some other details; whether further details are necessary is a moot point. As mentioned, I am only working on *reports* of the MA, so will not be able to give an accurate figure of everything that the MA has added to what was already known. Nevertheless, it is clear that most of the important points were already well known several years ago, as we see from this summary of the situation as it appeared, in 2001, in *Perceiving the Population Bomb*:

> For most of the details of damage in this category, it would be best to turn to a 1999 paper by David Pimentel et al. Incidentally, the paper also proposes the need to aim for a world population of 2 billion, although for different reasons from carbon dioxide emissions.[5] From it, we can add the following items to our list (all thoroughly referenced in the original):
>
> a) "3 billion humans malnourished worldwide;"
>
> b) "40,000 children die each day due to malnutrition and other diseases;"
>
> c) "Globally, the annual loss of land to urbanization and highways ranges from 10 to 35 million hectares per year, with half of this lost land coming from cropland;"
>
> d) "Worldwide, more than 10 million hectares of productive arable land are severely degraded and abandoned each year" (about 7% of the total per decade);
>
> e) "Water demands already far exceed supplies in nearly 80 nations of the world;"
>
> f) Since 1960, "nearly one-third of the world's arable land has been lost due to urbanization, highways, soil erosion, salinization, and water logging of the soil;"
>
> g) "grain production per capita started declining in 1984 and continues to decline;"
>
> h) "irrigation per capita started declining in 1978 and continues;"
>
> i) "food production per capita started declining in 1980 and continues;"
>
> j) "fertilizer supplies essential for food production started declining in 1989 and continues to do so."
>
> That abbreviated shortlist, which omits loss of soil — serious but difficult to measure — suffices to indicate the importance of the last of Smil's three categories, "declining availability of critical natural resources and services." However, perhaps we should also recall the *net* loss of forest, equal to an area of 12 million hectares (215 miles by 215 miles) per year.[6]

As relayed by *New Scientist* — and stressing again that we are relying only on two fairly brief summaries of the MA — these are the only points which might be worth adding to the above shortlist:

The MA said that "forests have been almost completely eradicated in 25 countries, at another 29 the area covered by forest has fallen by more than 90%."

On the eutrophication problem, the MA said: "Crop fertilization has doubled the availability of nitrogen worldwide since the mid-19th century and tripled the availability of phosphorus since 1960. This leads to eutrophication of lakes and rivers and creates dead zones on the ocean floor due to oxygen depletion." An important matter indeed. However, perhaps it should be pointed out that in *Wilderness and Plenty*, the 1969 Reith Lectures, Frank Frazer Darling emphasized the damage being done by eutrophication, so what the MA is saying is only providing quantitative evidence of the problem.

Turning briefly to the 30th March press release, many additional items were mentioned in a qualitative rather than quantitative way, but they really add little to the list above, which is entirely sufficient to give an overview of the extent to which humans have exceeded the Earth's carrying capacity.

Conclusion

It may seem churlish to put a low value on the additional information gathered by the MA, but the fact is that the MA report is likely to do more damage than good by focusing on details without recognizing the implications — implications which are so hugely difficult for the human race to accept. Should we be disappointed? I think not. It would be foolish to expect wisdom to emerge as a consensus from 1300 experts. For wisdom we need to turn to Clive Ponting's A *Green History of the World*[7] and David and Marcia Pimentel's *Food, Energy, and Society*.[8] The first shows that throughout 10,000 years of civilization humans have been pressing against the limits of their local ecosystems; the second, in a more scientific manner, shows why the Earth's ecosystemic limits mean that only about 2000 million humans could live in moderate comfort.

Endnotes

1. A slight variant of *Perceiving the Population Bomb* appeared in the journal of the World Watch Institute, *WorldWatch*. The original text was published in OPTJ 1. *Optimum Population Trust Newsletter*, October 2001 (an 'unofficial' start to the Journal). Manchester (U.K.): *Optimum Population Trust*. 8 pp. Archived on the web at www.members.aol.com/optjournal2/ optj1.doc

2. *The Crucial Limit: 11 cubic km of Carbon per Decade*, pp. 28-31 of OPTJ 3/2. *Optimum Population Trust Journal*, Vol. 3, No 2, October 2003. Manchester (U.K.): *Optimum Population Trust*. 32 pp. Archived on the web at www.members.aol.com/optjournal2/optj32.doc

3. See Review Essay of Vaclav Smil's 2003 book *Energy at the Crossroads* in OPTJ 5/1 pp. 9-13.

4. See Review Essay of Howard Hayden's 2004 book, *The Solar Fraud: Why Solar Energy Won't Run the World* (2nd edition), in OPTJ 5/1 pp. 3-8.

5. The paper is by D. Pimentel, O. Bailey, P. Kim, E. Mullaney, J. Calabrese, L. Walman, F. Nelson, and X. Yao, 1999. Will Limits of the Earth's Resources Control Human Numbers? *Environment, Development and Sustainability* 1: 19-39, 1999. It argues for a global population of 2 billion, on the basis of the amount of ecologically productive land needed to support humans in a tolerably good lifestyle from renewable resources. Our own research is based on similar analyses and we agree.

6. Page 26 of *Forest Futures: Population, Consumption and Wood Resources* by Tom Gardner-Outlaw and Robert Engelman, 1999, Population Action International. Based on FAO data, 200 million ha of natural forest were destroyed in the developing world, between 1980 and 1995, while there was an increase of 20 million ha of forest and forest plantations in developed countries (180 / 15 = 12 Mha/yr).

7. Ponting, C. 1991. *A Green History of the World*. First published in New York, by St Martin's Press, then by Penguin, in 1992, 432 pp.

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THE WAY: AN ECOLOGICAL WORLD-VIEW, OR THE TAO OF ECOLOGY

some thoughts from John Gray and Edward Goldsmith.

Although the main focus of the *OPT Journal* is a continuing attempt to decide where we, the human race, need to be going, perhaps there should be an occasional diversion to consider how to proceed, given the limitations of the human mind. John Gray, professor of European thought at the London School of Economics, in a review that he wrote for *The Independent*, 21 May 2004, of Peter Singer's book *The President of Good and Evil*, argued that human affairs are not guided by reason. The thought occurred to me whether we should even strive to make reason the basis for human society. I thought it would be interesting to ask John Gray and a few other people how they would answer the following question:

> Given the existing human condition, what 'cast of mind' is best suited to cope with it (and therefore to be promoted in schools and universities)?

I then gave more precision to meaning of 'cast of mind', as intending to refer either to minds guided by a particular religion, or sect of a religion, or minds in which reason — without 'benefit' of religion — is the guiding force. John Gray gave me his thoughts on the matter, from which I extract the following:

> A much smaller human population could have a much higher quality of life, sustainable for far longer and at much lower cost to other species. Such a world was envisaged by John Stuart Mill in the seminal chapter on *The Stationary State* in his *Principles of Political Economy* (1848). However, a combination of religious fundamentalist opposition, the refusal by mainstream political parties (including Greens) to confront the population issue and the intense pressure of existing human needs makes Mill's vision utopian. Instead, as in the past, the remedy for unsustainable human numbers looks like being along the lines described by the perennially unpopular Reverend Malthus.
>
> There seems to be little prospect that constructive action will be taken to avert a Malthusian solution, but the work of the OPT remains indispensable. Environmental and energy problems are insoluble at current levels of human numbers, let alone those projected for the future. This basic truth is worth repeating, even if hardly anyone is listening.

Edward Goldsmith, founder editor of *The Ecologist*, sent me his thoughts on the subject, from which I have taken this extract (as well as using, to head this page, the title of the book to which he refers):

> For me, the only societies that were truly sustainable and at the same time satisfied human needs, were the tribal societies of the past. If they managed to do so it was largely because of their world-view, which needless to say was totally religious. Their religion, whether we are talking about tribal peoples in Polynesia, Africa, India, or any other continent, were very similar in their details. All of them were what you might call cosmic religions. I describe these in chapters 61, 62 and 63 of my book *The Way: an Ecological World-View*, which in Italy, France, Spain, and other countries is entitled *The Tao of Ecology*. Unfortunately we have moved so far in the opposite direction that we have in effect delegated the task of solving our problems to the four horsemen of the apocalypse. After a sufficiently traumatic experience, when we shall probably have decimated the human species as well as most other species, people might find themselves out of necessity, living in family and communal groups, which provided the basis of a tribal society, and which would make it possible for them to be imbued once more with what has been the effective religion of mankind for 99% of our tenancy of this planet.

SCIENTIFIC AND JOURNALISTIC GOOFS

by Andrew R.B. Ferguson

Some people think that there are rather too many calculations shown in the OPT journals. However, an extract from a talk given to the National Defense University by Albert A. Bartlett, Professor Emeritus of physics at the University of Colorado, in December 2002, demonstrates the need for readers to *always check the arithmetic*. To set the scene for the two following pages of extracts, taken verbatim from Bartlett, we need to look at the data concerning U.S. coal reserves.

The basis for making the calculations are these. First, drawing on Bartlett, we can use *The Annual Energy Review, 1991*, published by the U.S. Department of Energy, which tells us that the "coal demonstrated reserve base" of the U.S. is 470 Gt (470 billion tonnes). There is a footnote to this saying, "About one-half of the demonstrated reserve base of coal in the United States is estimated to be recoverable." (This fifty percent reduction factor is to be expected, as a considerable amount of coal lies in non-viable, narrow seams).

Of course, were consumption to remain constant, it would be simple to determine how long the recoverable coal would last. It might be more difficult with increasing consumption, except that Bartlett provides a formula by which to calculate the time needed, during a period of exponential increase in annual consumption, to consume the remaining resource. Table 1 shows not only that time, but, more importantly, the time by which half the remaining recoverable resource would be used (see the main note on the table). Bartlett says several times, "You've just seen the facts." The facts he refers to are the ones presented in Table 1.

Table 1.
Life expectancy of U.S. coal for different rates of exponential growth in annual consumption:
(i) years remaining to consume all the recoverable coal, column B;
(ii) years remaining to consume half the recoverable coal, column C (implying the time at which consumption peaks, and after which there will be a steady decline)

Scientific and Journalist Goofs XLS.xls (10 April 2003)

4.70E+11	(470 Gt) is the estimated size of the resource, in tonnes
2.35E+11	(235 Gt) is the estimated size of the recoverable resource, in tonnes
1.18E+11	(118 Gt) is half of the estimated size of the recoverable resource, in tonnes.
9.90E+08	(990 Mt) is the 1991 rate of consumption in tonnes per year.

A	B	C	D	E	F	G	H
For this annual percent increase in the rate of consumption (i.e. the exponential growth rate).							
	Life, in years, of recoverable coal at exponential growth in consumption, at rate of column A.						
		Lifetime of HALF of the stock of recoverable coal at exponential growth in consumption, at rate of column A.					
8%	37	29					
7%	41	32					
6%	45	35					
5%	51	39					
4%	59	44					
3%	70	51					
2.86%	72	52					
2%	87	61					
1%	122	78					
0%	237	119					

Note that the figures in column B are not realistic, since there is no way in which production could continue to climb until there is no coal left. The figures are shown partly as these are the figures that are often presented, and partly because they provide a context within which to set the more realistic figures of column C. Column C shows the time at which *half* the remaining recoverable resource will have been produced, and therefore it can be expected, as it can with oil (not natural gas which is somewhat different due to the ease with which the gas can be extracted from the ground), that production will peak, and start on a downward path. Actually that is a simplification: the time is likely to be less, as peak is likely to occur when half the "ultimate" (i.e. original) recoverable resource has been used.

While 2.86% was the rate of growth in consumption between 1971 and 1991, a higher rate can probably be anticipated during the next half century, due to the coming scarcity of oil and gas. To use the table, if, for example, you think that 5% is a reasonable estimate, then you should expect the peak to occur 39 years after 1991, i.e. 2030.

The final paragraph of the notes in Table 1 use a 5% growth rate as an illustration. 5% is not unreasonable. Between 1850 and 1905, that is before oil and gas started to significantly usurp the role of coal, the growth in demand in the U.S. was 6.7% per year. In 2001, the U.S. imported about 60% of its oil and 15% of its natural gas. Because of this, exacerbated by U.S. population growing at over 1% a year, growth in coal consumption could soon be heading back toward the 6.7% per year of former times. Having set the scene, it is time to let Al Bartlett speak. First we will learn from him about the need to check the arithmetic, then we will go on to enjoy his comments concerning the popular notion of "Strength through Exhaustion."

ENERGY CRISIS; FACT OR FICTION? (extracts from pages 11-13)

by Albert A. Bartlett

The Energy Crisis of the 1970s

In the 1970s there was great national concern about energy, but this concern disappeared in the 1980s. The concern about energy in the 1970s prompted experts, journalists and scientists to assure the American people that there was no reason to be concerned. So let's go back now and look at some of these assurances from the 1970s so we can see what to expect as the energy crisis returns.

Here is the Director of the Energy Division of the Oak Ridge National Laboratories (Boulder *Daily Camera*, July 5, 1975):

> "We spent about $25 billion for imported oil last year," [the Director] said, adding that any reduction in the dependence on imported oil could be greatly aided by increased use of coal. *He estimated that America's coal reserves are so huge they could last, "a minimum of 300 years and probably a maximum of 1000 years."* [emphasis added]

You've just seen the facts. Now you see what an expert says. What can you conclude?

There was a three-hour television special on C.B.S. on energy (August 31, 1977). The reporter said:

> By the lowest estimate we have enough [coal] for 200 years, by the highest, enough for more than a thousand years.

You've just seen the facts. Now you see what a journalist says, after careful study. What can you conclude?

In the *Journal of Chemical Education* in the "Energy Review" for high school chemistry teachers we read an article by the scientific staff of the journal (April 1978, page 263):

> Our proved coal reserves are enormous (at least 120 billion tons). These could satisfy present U.S. energy needs for nearly 1000 years.

Let's do long division:

$$120 \times 10^9 \text{ tons} / 670 \times 10^6 \text{ tons per year} = 180 \text{ years.}$$

You take the coal they say is there, divide it by the then current rate of consumption and you get 180 years. But they didn't say "current rate of consumption." They said "present U.S. energy needs." Coal supplies about one fifth or about 20% of U.S. energy needs, so if you want to calculate how long their quantity of coal could "satisfy U.S. energy needs," you have to multiply the denominator by five. When you do that you get 36 years. *They said "nearly 1000 years."*

You have just seen the facts. Now you see what some scientists say. What can you conclude?

Some years ago I gave this talk (the expanded version) at a high school in Omaha. After the talk the high school physics teacher came to me. He had a book (*Energy and Economic Independence*, Energy Fuels Corporation, June 1976).

He asked, "Have you seen this?"

I had not seen it.

He said, "Look at this:"

> *"We've got coal coming out of our ears,"* as reported by *Forbes* magazine [That's a prominent business magazine; December 15, 1975, p. 28]. The United States holds 437 billion tons of known [coal] reserves [That's a good number]. That is equivalent to 1.8 trillion barrels of oil in British Thermal Units, or *enough energy to keep 100 million large electric generating plants going for the next 800 years or so*. [emphasis added]

The teacher said to me, "How could that be true? That's one large electric generating plant for every two people in the United States."

I said, "Of course, it can't be true. It's nuttier than a fruit cake. Let's do long division to see how crazy it is."

So you divide the coal they say is there, by what was then the current annual rate of consumption of coal and you find:

$$437 \times 10^9 / 655 \times 10^6 = 670 \text{ years.}$$

We could not keep up today's rate of consumption of coal for 800 years, and we hardly have 500 large generating plants in the United States.

Forbes magazine said it would be good for 100 million such plants.

So I give you a very fundamental observation.

> Don't believe any prediction of the life expectancy of a non-renewable resource until you have confirmed the prediction by repeating the calculation.
>
> As a corollary we have to note that the more optimistic the prediction, the greater is the probability that it is based on faulty arithmetic or on no arithmetic at all.

Strength through Exhaustion

Time magazine (May 19, 1975, p. 55) tells us that:

> Energy industries agree that to achieve some form of energy self-sufficiency the U.S. must mine all of the coal it can.

Think about this for just a moment. Let me paraphrase it.

> The more rapidly we consume our resources, the more self-sufficient we will be.

Isn't that what it says? David Brower called this:

> *The policy of strength through exhaustion.*

Here is an example of "strength through exhaustion." Here is William Simon, energy adviser to the President of the United States (Gerald Ford). Simon says (C.B.S. Television, August 31, 1977):

> We should be trying to get as many holes drilled as possible to get the proven [oil] reserve.

The more rapidly we can get the last oil up out of the ground and finish using it, the better off we will be!