The CO2 Newsletter, created, published, and edited by William N. Barbat, ran from 1979 to 1982.

In 2025, the family of Mr. Barbat donated an original set of all issues to Dr. Marc Hudson, and agreed that these could be digitised and placed online as a resource for anyone who wants to understand how long we've known about the carbon dioxide and global warming problem.

CO_2 Newsletter©

Volume 2 Number 5 **June-August 1981**

A bimonthly summary of advances in knowledge of the CO2-greenhouse problem, and of the social, political, and economic implications.

Arctic Warming Resembles the 1930s

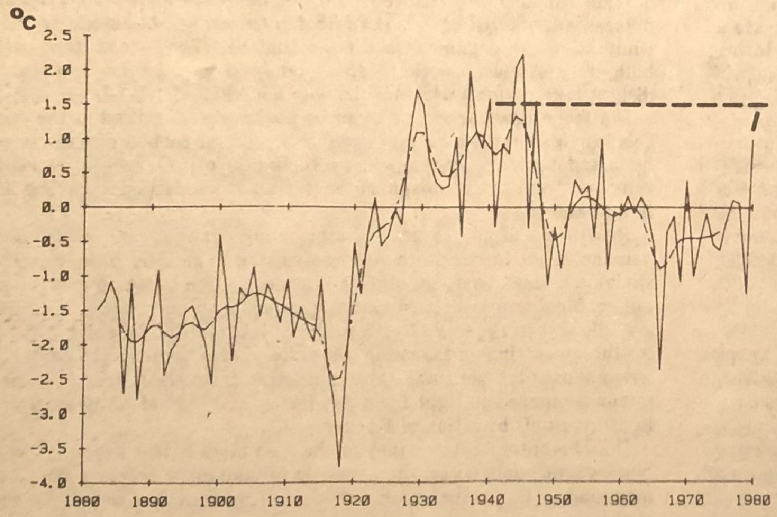
The cool winter temperatures in the Arctic in recent decades were interrupted by sudden warming which made winter of 1980-81 the seventh warmest Arctic winter since modern records have been kept. The accompanying temperature plot showing these temperatures was compiled by P.M. Kelly and P.D. Jones of the Climatic Research Unit of the University of East Anglia, and was published recently in *Climate Monitor.*

The principal direct effects of an increased greenhouse effect of CO_2 which can be monitored to detect change are temperature changes over a period of time as measured at the earth's surface. *Climate Monitor* presently is the only publication that provides up-to-date monitoring of the earth's temperatures by zones and seasons.(£20 per year, Climate Research Unit, U. of East Anglia, Norwich NR4 7TJ, England.)

Jones and Kelly have noted three distinct phases in the Arctic winter temperature record: a 'cold' period during the first decades of the record (1880-1920); a 'warm' period during the 1930s and 1940s; and an 'intermediate' period during the last three decades. The temperature of winter 1980-81 (+1.59°C) is reportedly comparable with the warmth of the late 1920s, 1930s and 1940s. During that warm era, outlet glaciers receded dramatically in Greenland, and Spitsbergen witnessed glacial surge. Whether the 1980-81 winter warmth signals the end of a natural cool cycle in the Northern Hemisphere and the beginning of a warm cycle with CO_2 signal reinforcement may not be determinable for some time.

Climate change is expected to result not from an increase in the absolute magnitude of global average temperature, but from a decrease in the temperature *difference* between cold polar and hot equatorial regions. This difference provides much of the driving energy which creates weather disturbances that bring cold polar air to mid-latitudes, causing much of the mid-latitude precipitation. Conforming to such a theory, the sudden Arctic warming of winter 1980-81 was accompanied by a decline in precipitation in the southerly parts of the U.S. and a serious snow drought in the mountain West.

A sudden weather change took place in April following a powerful explosion on the surface of the sun, which produced a great atmospheric disturbance on earth and bright auroral displays as far south as Tucson, Arizona (32°N) on April 12. Polar air masses then resumed meridianal flow, bringing large amounts of precipitation to many drought-parched areas in the U.S., and causing sudden and unexpected blizzards over large parts of England on April 23-26. These blizzards caused widespread disruptions to power supplies and transport and severe losses of livestock.



Arctic winter temperature anomalies deviations from the 1946-60 mean, with deviation for winter of 1980-81 (+1.59°C) projected. (Winter of 1939-40 = +1.60°C.) Modified from *Climate Monitor*, volume 10, number 1, 1981.

'First Order' CO2 Problems to Receive DoE Attention

Dr. Fred Koomanoff recently succeeded David Slade as director of the Department of Energy's CO_2 Climate Effects Research and Assessment Program. Slade will still be involved in climate studies in another part of DoE.

In a telephone interview, Koomanoff explained that no basic changes are in store for the 1981 budget, but that there may be changes down the road. He summed up his basic direction as trying to define if there is a CO_2 problem, acquiring hard data to give to decision makers, and concentrating primarily on first order problems. Koomanoff expressed concern that second and third order problems can become 'the tail that wags the dog'.

Also moving out of DoE's CO_2 program to other functions in DoE is Harry Moses. Moses had organized the **Workshop on First Detection of Carbon Dioxide Effects** held June 8-10, 1981 at Harpers Ferry, West Virginia. The program was reportedly put together on short notice, so Moses explained that the press purposely was not invited to allow participants time to revise papers and session reports before they are released.

Determining how to recognize carbon dioxide effects apparently occupied as much Workshop attention as detecting the effects once recognition criteria are agreed upon.

CO_2 Newsletter is published bimonthly by Wm. N. Barbat Associates (Energy Consultants), P.O. Box 24, Teton Village, Wyoming 83025. Deadlines for contributed articles and letters are Jan. 31, March 31, May 31, July 31, Sept. 30, and Nov. 30. U.S. subscription rates: Companies, institutions, or agencies $40 per year, which allows for unlimited 'in-house' reproduction rights; individuals and university libraries $20 per year (6 issues). Back issues $5 each as available. Foreign airmail, if sent from the U.S., add $4.

European subscription rate inclusive of postage: Swiss francs 48.—per year (6 issues).
Telephone: News or subscription information [307] 739-9799.
For all European subscriptions and for issues of back copies, contact Rudolf Trüb, CUMULUS FACHBUCHHANDLUNG, 5000 Aarau, Switzerland, Telephones 064 22 50 20 or 22 37 98.

"But meanwhile time flies, flies irreparably, while we, charmed with love [of our theme], linger around each single detail."

—Virgil

Editorial

The many controversies concerning the CO_2 problem tend to nullify scientific leadership and paralyze political action. Are there no qualified arbiters to settle such controversies? This question has bothered the U.S. Congress to the point where it has taken a wise action to obtain the best scientific advice obtainable.

The synfuels legislation of 1980 was enacted under coercion by the previous administration largely for the sake of national security. Environmental considerations were completely overwhelmed by the implied future shortages of gasoline and future dependency on insecure foreign supplies. Strong objections from a few knowledgeable CO_2 scientists were acknowledged but unheeded. The administrative agency responsible for an environmental evaluation downplayed the CO_2 problem in its analyses, and released the Review Draft to the public too late to permit input within the prescribed period for receiving comments.

While the U.S. Congress did pass the synfuels bill, Title 7 of the Energy Security Act of 1980 calls for the Director of the Office of Science and Technology Policy to contract with the National Academy of Sciences to obtain an assessment of the CO_2 problem within three years from the date of the act. This places the great responsibility for evaluating the profound ramifications, the controversies, and the uncertainties on a select group of highly qualified and respected scientists. The study is well under way under the leadership of William Nierenberg, director of Scripps Institution of Oceanography.

The original budget for the study was to be somewhere between $730,000 and $1,250,000, but this has been cut to $600,000 in the wave of thrift. This small amount contrasts sharply with the hundreds of millions of dollars awarded through this same legislation to create a domestic synfuels industry, which not only subsidizes a CO_2-producing source with a long industrial life in place of a potentially non-CO_2 producing energy industry, but also greatly increases the amount of CO_2 produced per gallon of gasoline over conventional fossil-fuel sources.

Readers will usually find us siding strongly with thrift in government and enterprise. But not in this case where the government is making a very small investment to assess what many qualified scientists consider to be the principal determinant of the country's environmental, economic, and possibly strategic destiny. There is no economic justification for not giving the NAS whatever funds it needs for the CO_2 evaluation, and for not letting NAS determine those needs.

●

What do people who are unfamiliar with the technical aspects of the CO_2 problem think of the CO_2 problem? Our speculation on this matter was partly cleared up when we received a phone call the other day from Petr Beckmann during which we arranged to exchange a subscription to our publication with his well-known *Access to Energy*, described as a 'pro-science, pro-technology, pro-free enterprise monthly newsletter' ($18/yr., Box 2298, Boulder, CO 80306).

From the conversation it was easy to sense that Professor Beckmann truly wishes to understand the CO_2 problem and how it may affect attitudes and policies toward energy, but that he was at a loss to gain such an understanding from the more widely circulated scientific publications. As it turned out, Professor Beckmann had written and published a brief article on CO_2 shortly before calling, and he apparently recognized some shortcomings. Some excerpts from the article:

"We are not unqualified supporters of nuclear power; we are unqualified supporters of the truth.

"Nuclear power has all the facts in its favor, and it does not need shaky arguments to support it. Climatic change by the 'greenhouse effect' due to fossil fuel burning is such a shaky argument. It is not necessarily false, but neither has it been conclusively shown true, and since we wrote about it (AtE Apr & June 79), it may have gotten shakier.

"... it is known that the carbon dioxide content of the atmosphere has been increasing for more than a century, and that the burning of fossil fuels is one of the sources that puts carbon dioxide into the air ... (D)eforestation, especially in the Third World, has made (vegetation) more of a net source than a sink of CO_2.

"But the known CO_2 budget does not balance: about 5 billion tons per year is now released by fossil-fuel burning, and some 14% of it disappears into a sink, which until recently has remained mysterious. Now four scientists ... have pointed to the large masses of organic material in the ecosystems near the continental shelves that get swept out into the ocean to the continental slopes.

"... If it is man who puts more CO_2 into the air, it is also man who puts more organic waste into the sea on continental shelves, makes the marine system thrive on it, and causes CO_2 absorption.

"The atmosphere and its complicated mechanisms are still too little understood to allow a final answer to the 'simple' question whether the contemporary increase of atmospheric CO_2 is due to fossil fuel burning or not."

Professor Beckmann is a highly conscientious, highly intelligent, well-read person, as evidenced by the depth and quality of his research on other energy related matters. What is evidenced here is a serious communications chasm between governmental agencies sponsoring research on CO_2 and people who would like to know like Professor Beckmann. It shouldn't fall on the editor of the *CO_2 Newsletter* to explain, "Yes, Virginia, there really is a CO_2 problem caused by fossil fuels."

The problems of balancing the carbon budget are complex, but just because someone proposes another possibly undiscovered hiding place for carbon, the whole problem of halting the CO_2 buildup is not then automatically solved. Certainly some science editor could better summarize the carbon budget controversy and its significance in regard to the duration of a man-caused CO_2 perturbation, but we will try. The ocean scientists, geophysicists, and carbon-budget modellers cannot find any place in the ocean to 'stuff' (their term) all the extra carbon dioxide supposedly produced by a net decrease in the biota through deforestation. Most of the ocean floor is oxidizing, not anoxic, so the accumulation of organic matter is limited. They toss the carbon budgetary problem back to the land biologists as an inventorying discrepancy on *land*, which is the way we lean.

If a large new carbon sink can be positively identified in the ocean, this implies that the rate of oceanic uptake of carbon dioxide is *very* fast, and that any man-made perturbation of CO_2 would be rapidly removed from the atmosphere once man stops releasing carbon from fixed reservoirs.

However, if a large missing sink cannot be conclusively demonstrated to reside in the oceans, then the land biota cannot be shrinking. Massive deforestation is a supposition based on meager samplings. Most tropical forest clearing is slash-and-burn where cut forests are allowed to *regrow* after 3 years of farming to replenish nutrients for future cutting and farming. Satellite photos taken in the dark of the moon show that the total light emanating from slash fires in Africa is minor compared to light from gas flares in mid-East oil fields and the light given off by cities of Europe.

If an inventory discrepancy in the land biota better explains the carbon budget misbalance, then oceanic uptake must be *very* slow, and a man-made CO_2 perturbation would then be expected to last for many centuries.

The goal of the *CO_2 Newsletter* has been to bridge this communications chasm on CO_2 between scientists, political leaders and the energy industry without sacrificing too much time from our income-producing business. (We regret the one-month slippage this issue due to the press of business.)

As to accomplishing our goal, we were heartened by a final note from Professor Beckmann:

"Many thanks for your shipment of past *CO_2 Newsletters*. Had I read them 2 weeks earlier, it would perhaps have made a difference to what I wrote in the August newsletter that I just printed."

We thank you too, Professor Beckmann, for broadening your understanding of the CO_2 problem. We sincerely believe that with enlightenment, many disagreements on energy and environment between opposing factions will dissolve.

Models and Analogs Agree: Warming Makes Wider Dry Belts

The scientific group of the Geophysical Fluid Dynamics Laboratory at Princeton cite two recent reports of theirs to correct an inaccurate and misleading statement of ours on the editorial page of the previous issue of this newsletter, namely: "If greater warming has resulted in ever-widening desert belts (based on studies of all the warm climates of the geologic past), this differs from the model results which infer that continued warming may cause an overall increase in precipitation."

The late Permian through mid Jurassic interval offers a very warm paleoclimatic analog, during which highly evaporative conditions existed over much of the continental portion of the earth, as evidenced by widespread salt deposits. At peak warmth about 200 million years ago in the Triassic Period, the average surface temperatures near the earth's poles may have been about 8° to 10°C according to A.A. Meyerhoff's synthesis. This is the average temperature today at Spokane, Denver and Milwaukee in the U.S. and at London, Berlin, Odessa and Seoul in the Eastern Hemisphere. During the Triassic the average temperature in the tropics may have been only 2° to 4°C warmer than now, which implies that the pole-to-equator temperature difference then was quite small.

In 'Sensitivity of a Global Climate Model to an Increase of CO_2 Concentration in the Atmosphere' (*Journal of Geophysics*, October 20, 1980) Syukuro Manabe and Ronald J. Stouffer have modeled the latitude-time distribution of the zonal mean difference in **precipitation minus evaporation** (P - E) between 4 X CO_2 and 1 X CO_2. The authors point out that (P - E) increases in high latitudes in response to the increase of CO_2 concentration, but over the continents, the belts of both positive and negative (P - E) differences undergo large latitudinal shifts from one season to another.

Their model shows that the belt of negative difference is located at about 25° N in January, whereas a wide belt of negative (P - E) difference extends from about 30° N to 70° N in May. (30° N corresponds to the latitude of Houston and Tallahassee in the U.S. and approximately Casablanca, Cairo, Abadan, Delhi and Shanghai in the Eastern Hemisphere; 70° N is above the Arctic circle.) Over the continents in the Southern Hemisphere, their model shows only small-scale characteristics because continental areas comprise only a small fraction of the region poleward from 30° S.

The seasonal differences in precipitation and evaporation have been translated further by the authors into variations of soil wetness. According to their work, "the region of enhanced soil wetness in the northern hemisphere expands toward the mid-latitudes in winter but retracts poleward in summer. On the other hand, the zonal mean soil wetness reduces in two separate regions centered around 45° N in summer and 70° N during the warm season. The zone of enhanced dryness around 45° N in summer results from the poleward shift of the mid-latitude rainbelt . . . The enhanced dryness around 70° N results partly from the elongation of the warm drying season owing to the earlier timing of the late spring snowmelt . . ."

In another article, 'Influence of Seasonal Variation Upon the Sensitivity of a Model Climate' (*Journal of Geophysics*, February 20, 1981), Richard T. Wetherald and Syukuro Manabe report that "in summer the zonal mean wetness is reduced extensively over two separate zones of middle and high latitudes in response to the CO_2 increase, respectively." They further note, "In high latitudes the spring snowmelt in the 4 X CO_2 experiment occurs approximately 1 month earlier than in the 1 X CO_2 experiment owing to the warmer surface air temperature . . . The earlier snowmelt season in the 4 X CO_2 experiment implies a longer duration of the warm period when the soil moisture tends to decrease . . . This reduction of soil wetness in high latitudes together with the aforementioned reduction in middle latitudes yields an extensive zone of reduced wetness which is evident in Figure 17. During the remainder of the year (i.e., from fall to spring) the soil wetness increases from the 1 X CO_2 to the 4 X CO_2 . . ."

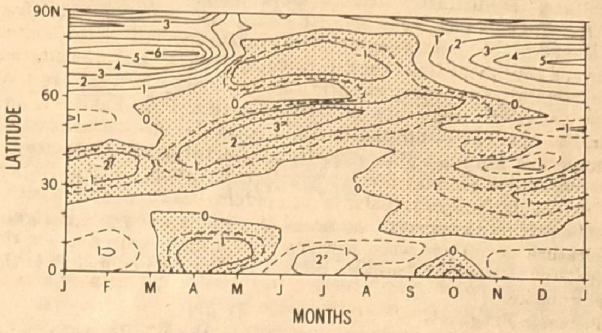


Figure 17 from 'Influence of Seasonal Variation Upon the Sensitivity of a Model Climate' by R.T. Wetherald and S. Manabe, Latitude-time distribution of the seasonal variation of the zonal mean difference in the soil moisture (cm) between the (1 X CO_2) and (4 X CO_2) experiments with seasonal model. The field capacity of soil moisture is assumed to be 15 cm and is constant everywhere. The distributions of the two hemispheres of the model are averaged after shifting the phase of southern hemisphere variation by 6 months.

From *Journal of Geophysics*, volume 86, number C2, February 20, 1981. (Not subject to U.S. copyright.)

Excerpts from recent reports

From **'Adaptation to Global Environmental Change' by Karl W. Butzer, published in Professional Geographer, volume 32, number 3, pages 269-278 (1980):**

". . . Although objective measures of adaptive success are difficult to define in cultural terms, adaptation, as a strategy for survival, provides a practicable focus for empirical study. . .

"Recent climatic anamolies provide examples of the significance of small-scale environmental variabililty: the exceptionally cold winters of 1976-79 in parts of North America and Europe exacerbated dependence upon imported petroleum, while a sequence of bad harvests in the Soviet Union required massive grain imports. At a higher order of variability, the Dust Bowl years served to reverse two generations of adaptive development on the Great Plains, setting in train important internal migrations. . .

". . . Somewhat belatedly, attention was focused upon the dramatic transformation of recent centuries - cultural degradation whereby natural ecosystems have been drastically simplified and their stability maintained at an increasingly high cost of artificial intervention . . . This trajectory of intensifying environmental transformation has created a metastable equilibrium, the component interbalance of which is becoming conditioned upon persistent net economic growth . . . .

"Atmospheric Carbon Dioxide Projections

" . . . The readjustment of the global carbon cycle . . . that began during the mid-nineteenth century continues to increase the level of atmospheric carbon dioxide . . . The voracious need of industrial societies for energy continues to release vast quantities of previously fixed carbon dioxide from fossil fuels into the atmosphere . . .

". . . Barring an unlikely, large-scale reversal in energy consumption patterns and land use practices, long-term global planning must anticipate a doubling of atmospheric carbon dioxide within less than a century.

"Climatic Prediction

" . . . The provisional consensus is that the augmented greenhouse effect will raise mean temperatures in the lower troposphere by at least 2 or 3°C . . . although change will be minimal in the tropics but somewhat greater in middle and higher latitudes . . . Such a restructuring of atmospheric energy gradients represents a major planetary change of an amplitude surpassing any experienced during the past ten millenia.

"The closest paleoclimate parallels for such conditions would be the warmest phases of certain Pleistocene interglacials . . . during which many world biomes were changed in terms of demarcation as well as physiognomic and general detail, but without promoting a major change in the regimen of the Greenland and Antarctic ice sheets. However, paleoclimatic reconstructions for the interglacials are insufficiently detailed to provide a useful model for potential anomalies during the mid-twenty-first century. The best analogy, consequently, is the mid-Holocene Altithermal or Hypsithermal of 8,000 to 5,000 years ago . . . (when) mean temperatures were 1.5 to 2.5°C higher than today in middle latitudes as well as at high elevations.

"The implications of higher mid-Holocene temperatures include a longer growing season and poleward extension of the tree line in Alaska . . , Canada . . , and northern Europe . . , together with an upward shift of montane ecozones in Europe . . , the western U.S.A. . . ,

southeastern Australia . . . and elsewhere. Rainfall increased throughout the Sahara . . . in East Africa . . . Arabia . . . the Thar Desert . . . the Kalahari and Karoo of southern Africa . . . and across Australia . . . although there were several marked dry spells within this generally moist time span . . . In the American Midwest and on the Great Plains, climate was distinctly drier than today, with expansion of prairie at the expense of forest in Minnesota, Illinois, and Missouri . . . Climate was at least as dry as today in the basins - but not in the mountains - of the West, judging by low lake levels . . . (L)acking are properly dated pollen or lake sequences of this age in Southern Russia, Central Asia, and Mongolia, although a shrunken, saline lake in the then nonforested Van Basin of eastern Anatolia . . . suggests that continental positions comparable to the western and central United States may also have been drier in Eurasia. Such an interpretation finds strong support in the extensive Caspian Basin, with a sea level 25 m lower than in historical times during the mid-Holocene . . . The Mediterranean Basin experienced no climatic disruptions . . . but southernmost Africa was drier . . . and unpublished pollen studies by V. Markgraf suggest that the foothills of the Argentinian Andes were also drier.

"The basic mid-Holocene pattern is as follows: (a) substantially augmented growing seasons in cool environments now marginal for agriculture; (b) distinctly drier climate in most midlatitude arid, semiarid, and subhumid regions, with an inherent trend to desertification, including the major wheat- and corn-producing belts of the United States and the Soviet Union; and (c) moderately increased precipitation in the tropical and subtropical arid zone, primarily in what are now pastoral and irrigated lands of Africa, Arabia, India-Pakistan, and Australia, but excepting the more productive mediterranean environments of Europe and South Africa . . . Quantitative data are far more speculative but may involve negative deviations of 20 or 30 percent in the hydrological balance of middle latitudes and positive anomalies of 30 to 50 percent in lower latitudes. Because mid-Holocene temperature deviations were perhaps half of those expected for the twenty-first century, the upper range of these crude estimates is the more probable.

"Economic Prognosis

"The agricultural implications suggested by the mid-Holocene model (Figure 1) for the twenty-first century are mixed and in certain important ways, negative overall . . . Dust Bowl conditions should become commonplace on the Great Plains, with an increased incidence of drought in the Midwest. A substantial part of the present winter-wheat belt would have to revert to grazing, with large-scale replacement of the corn-soybean production of Illinois, Iowa, and Missouri by winter wheat. The corn belt would shift, climatically to Wisconsin, Minnesota, and Canada, where podsolized soils are poorer and drainage less ideal. Irrigation waters of the West would be substantially reduced and less reliable. Overall United States crop acreage and average yield would plummet, and corn - with its attendant livestock industry - would be replaced by wheat of substantially lower productivity. Similar problems can be expected to plague food production in the Ukraine and Central Asia. By comparison, the potential expansion of agriculture onto the marginal soils of the mixed coniferous forest belt of Canada and northern Europe would be relatively insignificant.

"Increased moisture in the low-latitude deserts and semi-arid zone of Africa, Asia, Australia, and parts of South America would primarily affect the productivity of low-efficiency pastoral economies, only locally supplemented with agriculture. Even increased yields in the subsistence-agriculture belt of the Old and New World tropics would not add substantially to the world food supply, probably serving only to accelerate demographic expansion. In effect, long-range benefits could be assured only by a protracted program of carefully tailored agriculture modernization, soil ameliorization, and large-scale irrigation schemes - all of which require heavy and sustained capital investment in countries lacking both industrial capacity and energy resources . . .

"One related issue that has also been raised concerns increased, possibly catastrophic melting of the residual Greenland and Antarctic ice sheets . . . One of the erroneous assumptions here is that, because Pleistocene interglacial shorelines can commonly be identified well above those of the present, there was greater melting of the present ice sheets, returning more water to the world ocean. Instead, however, continuous records of deep-sea sedimentation identify only two brief intervals when ocean surface waters were even slightly warmer than those of the mid-Holocene, and even here the salinities indicated argue for a world glaciological balance not substantially different from that of the moment . . . Also, during mid-Holocene times, absolute sea level remained very much within its present, limited range of fluctuation, from 0.5 m above to 2.5 m below that of today . . .

"Despite this skepticism in regard to projected shoreline change, the overall qualitative scenario outlined here for the world food supply is decidedly negative . . . (T)he United States, now the world's major food exporter, will barely remain self-sufficient, while the Soviet Union will be heavily dependent upon food imports. Unless demographic trends in low-latitude, Fourth World nations are reversed, and agricultural productivity at least doubled, Canada's and Australia's sustained capacity to export will be quite inadequate to meet world demand for food.

"There is then every reason to believe that a continuation of present environmental trends will spell an economic crisis of global proportions within the lifetimes of our children and grandchildren. The negative impacts of such cumulative change will affect some countries, such as the two present superpowers, the United States and the Soviet Union, far more than others, creating severe tensions in the global sociopolitical network . . . The pending crisis of the twenty-first century can thus be expected to take three forms:

"(a) A substantial reduction of the world food supply, at a time of maximum demographic pressures upon global resources and shrinking energy reserves;

"(b) selective decline of productivity among the major economic and food-producing nations, implying a fundamental readjustment between developed and developing regions; and

"(c) differential impacts within undersupplied nations of special complexity, suggesting severe internal disruptions within existing socioeconomic fabrics, e.g., between the haves and have-nots.

"Discussion

". . . elaborate cultural systems enjoy centuries of adaptive equilibrium, with or without sustained growth, followed by discontinuities . . .

"It requires no elaboration to demonstrate that short-term strategies are the rule rather than the exception in modern democracies, where the timetable of elections dictates cost-benefit analysis. Even the 'five-year' economic plans of one-party socialist states are short range and exceeded only by military projections. The United States lacks a comprehensive energy plan after five years of high-level discussions . . . (S)ocieties around the globe are likely to stumble through the mounting crises that spell out exactly the sort of concatenation of negative inputs that requires drastic systemic readjustment for survival.

"If this does indeed happen, environmental change in the twenty-first century is bound to have revolutionary results in economic, political, demographic, and social terms. Spatial economic gradients will be reversed and existing political configurations will disappear, with radical redefinitions of the bases of world power. Demographic repercussions will surpass those of the Black Death in fourteenth-century Europe, on a global rather than regional scale. In the wake of such fundamental realignments, unknown in any previous period of human history, some sociocultural systems will disintegrate and lose their identities, as the price for rudimentary survival.

"The alternative is multi-level, long-range planning in both national and international contexts. The carbon dioxide problem is closely linked with that of energy conservation, and it calls for immediate and draconian, comprehensive programs, both to decelerate the combustion of fossil fuels and to develop nonpolluting sources for sustained energy yields. The worldwide trend to deforestation must be arrested, and systematic reforestation of suitable, agriculturally marginal lands begun . . . (T)he environmental change for mid-century might yet be averted or at least slowed and so reduced in magnitude as to remain within the scope of normal systemic readjustment.

". . . The collision course between environmentalists and conservation principles must be averted and a fresh set of common goals defined. The middle and especially the upper economic classes must be convinced that material comforts need to be significantly curtailed. Finally, at all levels of society there must be a pragmatic reallocation of national priorities in all spheres from microeconomics to national policy. . .

". . . To avoid yet another ideological movement, more concerned with slogans than information, there must also be a great deal more research on climatic, energy, and agricultural themes that emphasizes historical experience, simulation of future trends, and better understanding of contemporary processes and relationships. Only when a cultural system accepts new information that is consonant with its value systems can there be successful behavioral adaptation."

●

From **'Climate Impact of Increasing Atmospheric Carbon Dioxide', by J. Hansen, D. Johnson, A. Lacis, S. Lebedeff, P. Lee, D. Rind, and G. Russell, SCIENCE 28 August 1981:**

Summary. The global temperature rose by 0.2°C between the middle 1960s and 1980, yielding a warming of 0.4°C in the past century. This temperature increase is consistent with the calculated greenhouse effect due to measured increases of atmospheric carbon dioxide. Variations of volcanic aerosols and possibly solar luminosity appear to be primary causes of observed fluctuations about the mean trend of increasing temperature. It is shown that the anthropogenic carbon dioxide

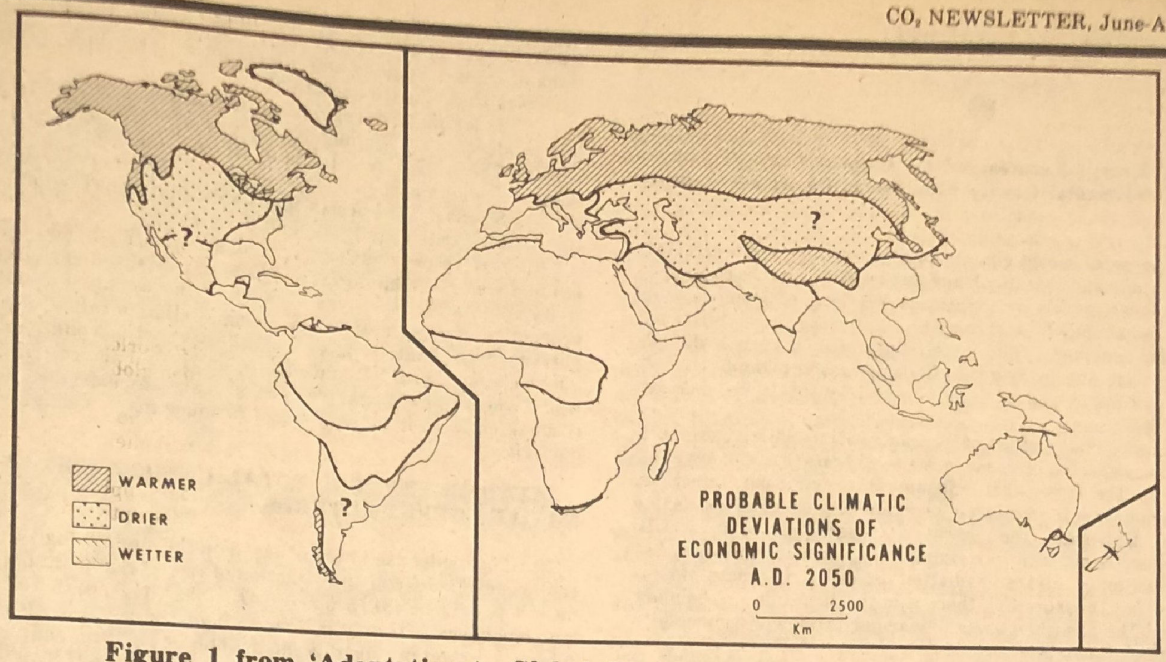


Figure 1 from 'Adaptation to Global Environmental Change', by Karl W. Butzer, published in Professional Geographer, August 1980. (Copyright 1980 by Association of American Geographers, reproduced by permission).

warming should emerge from the noise level of natural climate variability by the end of the century, and there is a high probability of warming in the 1980s. Potential effects on climate in the 21st century include the creation of drought-prone regions in North America and central Asia as part of a shifting of climatic zones, erosion of the West Antarctic ice sheet with a consequent worldwide rise in sea level, and opening in the fabled Northwest Passage."."

●

From 'Comments on "Aerosol, Cloud Reflectivity and Climate" ', by William W. Kellogg, Journal of the Atmospheric Sciences, volume 38, March 1981:

The recent short report by Charlock and Sellers (1980) in this journal dealt with the application of a one-dimensional radiative-convection model to the question of how aerosols interact with low-level clouds to change the cloud albedo, and hence influence the heat balance of the troposphere . . . I wish to point out that their conclusions that more aerosols result in higher cloud albedo and a surface cooling is based in part on an incorrect choice of aerosol optical properties.

". . . If an increase of aerosol concentration in the lower troposphere occurs, it is not unreasonable to expect a corresponding increase in cloud condensation nuclei (CCN), and this will increase the cloud-droplet concentration and *increase* the cloud albedo, a relationship pointed out by Twomey (1977). Such an effect (does not depend) on the optical properties of the aerosols.

"A second effect, however, does depend on the aerosol optical properties, specifically on whether they absorb solar radiation. If light-absorbing particles are incorporated into a thick cloud they generally *lower* the cloud albedo, and this takes place whether the absorbing particles are incorporated within the droplets or remain in the air between droplets . . . An exception to this occurs when the cloud layers are quite thin, and only then may the cloud albedo be slightly increased.

"An extensive review of published observations of aerosol optical properties has been carried out recently by this author . . . and the conclusion is that virtually all aerosols do absorb solar radiation, especially industrial aerosols, smoke, and wind-blown dust (which only leaves marine aerosols and they are little affected by human activities). In fact, aerosol absorption-to-backscatter ratio is generally so large that when in cloud-free lower layers over land with an albedo of 0.15 or greater they cause a warming of the surface plus lower atmosphere; and since thier sources are mostly the land surface, that is where most of them are to be found. If they lower the albedo of cloud tops, then they would tend to cause a warming in a cloudy atmosphere as well. (Incidentally, taking the effect of aerosols on infrared flux into account slightly enhances the warming influence . . .)

"The reason Charlock and Sellers come to the conclusion that aerosols in cloudy air increase cloud albedo and cause a cooling is that they adopt the theoretical results of Twomey (1977) for *thin* clouds, thereby selecting a special case where albedo may be increased. It should also be noted that Twomey considered in his calculations relatively low-absorbing continental aerosols sample in Big Springs, Texas, and Blyth, California.

"As for the non-cloudy air, they cite the aerosol properties calculated theoretically by Toon and Pollack (1976), which were assumed to be sulfate or sulfuric acid particles. Pure sulfate particles apparently do not exist in the real atmosphere, though sulfates are recognized as the dominant species in aerosols whose sources are industrialized regions . . . There are nearly always enough small light-absorbing particles, usually some form of soot or soil, to combine with the sulfate and render the resulting inhomogeneous particles absorbing as a whole. (An exception may be in air masses that have been over the open ocean for a long time.) That is why white filters used to collect aerosols almost everywhere over land usually turn gray or brown after exposure.

". . . The currently discredited idea that anthropogenic aerosols can cause a global cooling (and hence perhaps even counteract the warming effect of adding carbon dioxide to the atmosphere) should not be given a new lease on life by a misleading theoretical calculation that uses inappropriate inputs."

From 'Reply', by Thomas P. Charlock and William D. Sellers:

". . . (A)s clearly stated in both the abstract and opening paragraph of our brief note, our intent was to address the effects of CCN and cloud albedo on climate (not other aerosol effects mentioned by Kellogg) . . . .

". . . (O)ur calculations were made with a thin cloud assumption. The same qualitative results should apply for all but the thickest or most highly polluted clouds . . .

". . . Our introduction of the Toon and Pollack aerosol was not a suggestion that anthropogenic aerosols have the same physical composition as Toon and Pollack aerosols . . .

"Also, we are well aware that an increase in aerosols of certain physical composition can cause a surface heating . . . The point of our note was to show that an anthropogenic increase in CCN, one component of aerosol which is not even monitored on a global basis at present, could cause global cooling. It is possible for the (non CCN) aerosol to cause a net surface heating if the ratio of aerosol absorption to extinction is high enough. But a recent determination with spectrophone techniques (Foot, 1979) indicates that this ratio may be sufficiently small (0.8-2.5%), even for aerosol in which smoke was a major contribution, for cloudless aerosol cooling (scattering) effects to dominate heating (absorption) effects. Present uncertainties regarding both the imaginary indices of refraction and shape effects of atmospheric aerosols makes it difficult to judge whether aerosols cause a net cooling or heating of the globe . . .

". . . CCN are a small fraction of aerosol mass, but their optical effects are fairly large. Before the last word on climatic effect of aerosols is given, there must be a global monitoring of CCN."

From **'Global Energy Futures and the Carbon Dioxide Problem', Council on Environmental Quality (Gus Speth, Chairman), January 13, 1981:**

". . . the response of world climate to elevated CO_2 concentrations must be estimated from theoretical models that simulate the climate. A 1979 review of these models by a National Academy of Sciences panel reached conclusions which it said 'may be comforting to scientists but disturbing to policymakers.' The panel continued: 'If carbon dioxide continues to increase, the study group finds no reason to doubt that climate changes will result and no reason to believe that these changes will be negligible'.

"The most direct climatic effect of increasing atmospheric concentrations of CO_2 is the expected increase in the temperature of the lower atmosphere due to the (somewhat misnamed) 'greenhouse' effect. (A greenhouse warms its contents largely by reducing thermal losses due to convection. However, the warming associated with a CO_2 'greenhouse' effect is not due to a reduction of convection losses but rather to a reduction in infrared radiation losses.) . . . Climate models generally agree that the more CO_2 there is in the atmosphere, the more radiated heat will be absorbed and the warmer the lower atmosphere will become, other things being equal . . .

"Unless counteracted by other climatic factors . . . the temperature rise generally associated with a doubling of atmospheric CO_2 concentrations over pre-industrial levels—about 3°C—would take the world's climate outside the range that has generally prevailed for the last several thousand years . . ."

"In addition to CO_2, other trace gases produced by human activities can contribute to the 'greenhouse' effect . . . The effects of these gases, however, are generally not taken into account in existing models. These gases include nitrous oxide (N_2O), methane (CH_4), Ozone (O_3), and the class of chloroflourocarbons (e.g., CCl_2F_2, CCl_3F)...

"This report focuses only on the climatic effects caused by atmospheric CO_2. It is important to note however, that the total rise in global temperature actually realized may be significantly higher (perhaps as much as 40 percent) than the warming due only to CO_2 fossil fuel combustion . . .

"Increased summer temperatures might be too high for optimum productivity for some crops presently grown in the midlatitudes, such as corn and soybeans. As a result, the Corn Belt might have to shift toward the north, where much of the soil is less suitable for agriculture. . .

"It is possible that world wheat production could also be limited by the drier, warmer conditions that might prevail in some of the present wheat producing areas of the world. For example, a combined temperature increase of 1°C and precipitation decrease of 10 percent might reduce crop yields by 20 percent in major wheat-producing areas, such as in the USSR and the United States . . .

"Rice production could rise with higher temperatures, provided that the monsoon rains did not decrease or cause flooding.

"Insect populations generally increase with an increase in temperature. Thus, a warmer global climate may make pest control more difficult . . ."

"Even though temperature changes in the Antarctic region would be expected to be less than those in the Arctic, a doubling of atmospheric CO_2 might be sufficient to lead to a disintegration of the (West Antarctic) ice sheet . . . It is estimated that sea level might rise an average of 5 meters, or possibly up to 8 meters in some locations, following deglaciation of West Antarctica, which could have profound effects on the shorelands of the world . . . The likelihood of such an event, along with its rate and timing, is uncertain and controversial . . . If it were to occur, disintegration might begin within a few years of significant Antarctic warming and might take a few decades to a few centuries for completion . . .

"Socioeconomic Impacts: The risk of Rapid Disruptive Change

". . . Coastal flooding, resulting from a breakup of the protective West Antarctic ice shelves and a surging of the ice sheet into the ocean, could raise the sea level 5-8 meters and could occur over a period as short as a few decades or as long as a few centuries . . . If such a rise in sea levels were to occur over several decades, it would have enormous implications for coastal cities and states throughout the world. For example a 5-meter rise would flood areas in the United States occupied by 11 million people, about 5 percent of the population; an 8-meter rise would flood areas inhabited by about 7 percent of the population. . .

". . . the most serious effects on agriculture are likely to arise not from changes in average global conditions but from shifts in the locations of climate regions and effects on water supply, pests, and other variables that climate can affect . . .

". . . the fertile farm regions of the Midwest and South might become less productive . . . Regionally, more arid conditions might limit agricultural production over parts of North America, Asia, and Northern Africa . . . whereas regions farther north might become subject to flooding . . . Similarly, the Asian monsoons might shift, significantly affecting nations that heavily depend upon them . . .

"Altered water levels in lakes and streams, changed patterns of rainfall and water availability, and shifts in centers of agricultural productivity could affect the lives of much of the world's population and the economies of most nations. A changed climate might alter wheat exports from the United States and other exporting countries, with consequent changes in GNP and effects on trade balances. In parts of the world where agricultural production is already marginal, even relatively small changes in climate might produce major changes in total productivity . . .

"ATMOSPHERIC CO_2, TOTAL ENERGY USE AND ALTERNATIVE ENERGY FUTURES

". . . The model used here is based on the simplifying assumption that each year a fixed, constant fraction of the total amount of CO_2 in the atmosphere will be taken up by CO_2 sinks—the ocean and perhaps the land biosphere. The average emission factor used was 20 million tons of released carbon per quad [a quadrillion or 10^{15} btu, equivalent roughly to present electrical use of 10 million people in the U.S. or about the use of about 0.5 million barrels per day of petroleum] of fossil fuel burned. This assumption corresponds to the present global mix of fossil fuels and probably provides a low estimate of future CO_2 emissions. Further, because the oceans' effectiveness as a sink will probably decrease at higher atmospheric CO_2 levels, the model should underpredict the long-term concentration of atmospheric CO_2 expected to result from burning a given amount of fossil fuel . . .

"Atmospheric CO_2 Concentrations Resulting from Unrestrained Combustion of Fossil Fuels

". . . before global fossil fuel resources can be completely used, CO_2 concentrations (regardless of the assumed rate of increase) will have risen to levels at which, other things being equal, disastrous climate modifications would appear inevitable . . .

"The Effects on Fossil Fuel Use of Limiting Future Atmospheric CO_2 Concentrations

". . . there is no unique curve leading to a fixed, long-term atmospheric CO_2 concentration. Many energy futures could lead to the same CO_2 concentration . . .

". . . the more rapidly the world increases fossil fuel use now, the sooner and more rapidly it must begin its reduction in order to avoid exceeding any given CO_2 ceiling . . .

"Holding atmospheric CO_2 buildup below twice the pre-industrial level will permit only small and temporary annual increases in fossil fuel use. Rather than growing at between 2 to 5 percent per year growth rate, the fossil fuel growth would start at maximum values in 1980 of between 1.0 and 1.5 percent per year, depending on the scenario, and decline thereafter for the next several decades . . .

". . . if a global goal were eventually adopted of not exceeding a 50 or 100 percent increase in atmospheric CO_2, a continuation of relatively high fossil fuel growth for an additional decade (the 1980s) would make the transition away from fossil fuels in the next century more demanding, given likely economic and institutional commitments . . .

"SUMMARY AND RECOMMENDATIONS

". . . Given the long planning and implementation lead times involved in forging a transition to a new energy future, the planning for the transition would need to begin now if it is to be orderly . . .

". . . significant amounts of nonfossil fuel energy will be needed if CO_2 levels are to be limited . . .

". . . there is an understandable tendency to postpone an international response in the belief that there will be adequate time to act once climate changes are actually observed . . .

". . . the required rate of introduction of new energy sources might have to be greater than any experienced in the past.

"Compounding this problem is the fact that vast amounts of new capital will probably have been invested globally in new fossil-based energy sources (including coal and oil shales) virtually committing nations and their industries to use these facilities for their 30-40 year lifetimes . . .

"Recommendations

"1. Assign a High Priority to Incorporating the CO_2 Issue into U.S. Energy Policy Planning

"... Efforts should be started immediately to develop and examine alternative global energy futures with emphasis on regional analysis...

"Maintaining great flexibility in energy supply policies also implies that energy policies that commit the world to large-scale and long-term use of coal and oil shale (because of their great abundance) should be avoided, given current understanding of CO_2 risks ...

"2. Increase Reliance on Energy Conservation and Renewable Sources of Energy ..."

"3. Undertake New and Expanded Cooperative International Efforts to Address CO_2 Issues ..."

●

From 'The Albedo Effect', advertisement by General Motors Corporation in SCIENTIFIC AMERICAN (July 1981) and other popularized-science magazines:

"... Fundamental studies conducted at the General Motors Research Laboratory explore the effect of various atmospheric factors, natural and man-made, on the earth's thermal balance.

"New knowledge of the influence of airborne particles on the earth's thermal balance has been revealed by investigations carried out by Ruth Reck. Dr. Reck's work at General Motors integrated for the first time the complex factor of particles into radiative-convective atmospheric models ...

"Airborne particles have many sources: volcanic issue, wind-raised dust and sea salt, ash, soot, direct and indirect products of combustion and industrial processing, the products of the decay of plant and animal life, the liquid droplets and ice crystals that make up clouds. Particles alter the radiation flow in the atmosphere by the processes of scattering and absorption. Particles differ by size and composition, factors which determine optical properties.

"Prior to Dr. Reck's work, models for calculating the vertical temperature profile included layers of clouds and the significant gases - O_2, O_3, H_20 and CO_2 - but neglected the particle factor ...

Dr. Reck's contribution was to add the particle factor to a one-dimensional model ... (which) divides the atmosphere into nine layers ..

"The particles of interest, known as Mie-scattering aerosols, are comparable in size to the wavelength of the incident radiation, Dr. Reck models the interaction of these particles with the radiation field in terms of two parameters: the single scattering albedo of the particle, which describes backscatter, and an anisotropic scattering factor which measures the degree of forward scatter. From these two quantities and the size distribution and abundance of the particles, the transmission, absorption and backscatter of each layer in the model can be calculated.

"Dr. Reck discovered that whether particles have a heating or cooling influence depends upon the surface albedo, or reflective power of the earth directly beneath them ... Her results indicate that when surface albedo is small, the net effect of particles is to 'shield' the earth from incoming solar radiation, producing a cooling influence. When surface albedo is large, a trapping effect prevails, in which a portion of solar radiation that reaches the earth's surface is 'trapped' between the surface and the particles, producing a net heating influence ...

"Dr. Reck calculated that for the latitudes between the equator and 35°N, where average surface albedo is low, the current background level of atmospheric particles decreases solar radiation reaching the earth by 1%, thus producing a net cooling effect. Her findings indicate that heating takes place at latitudes north of 55°N, where average surface albedo is high ..."

●

From 'Recent glacier variations and volanic eruptions', by Stephen C. Porter, NATURE 14 May 1981:

The injection of volcanic dust and gases into the atmosphere during major eruptions has been advanced to explain short-term variations of climate ... A calculated global cooling of ~1 K during episodes of intense volcanic activity ... could lead to a snowline depression sufficient to cause glacier advances equivalent to those of the last several centuries. The hypothesis would therefore be strengthened if a close relationship could be demonstrated between global volcanic activity and the pattern of recent glacial variations. Glacier activity in the Northern Hemisphere during much of the past 100 yr shows a lack of synchrony with that in the Southern Hemisphere, but in each hemisphere the sequence of glacier variations matches the acidity record in polar ice cores and the frequency of volcanic eruptions in successive latitude belts. This suggests that glaciers fluc ate in response to atmospheric buildup of volcanic aerosols produced during large eruptions and that explosive volcanism may therefore be a major factor in modulating climate on the decadal scale ..."

●

From "Biological export of shelf carbon is a sink of the global CO_2 cycle', by John J. Walsh, Gilbert T. Rowe Richard L. Iverson & C. Peter McRoy, NATURE 21 May 1981:

"Measurements of carbon metabolism, production and exchange along food webs suggest that large fractions of the organic matter produced on continental shelves must be exported to continental slopes. The annual loss of organic matter from continental shelf ecosystems is far greater than in the open ocean. If part of the loss of nearshore primary production has increased in those coastal zones where anthropogenic inorganic nutrient supplies have been consistently increasing since the industrial revolution, then burial and diagenesis of this material in slope depocentres could represent the 'missing BMTs of carbon' in global budgets."

- Abstract.

●

From **'Historical Nile Floods and Their Implications for Climatic Change', by Fekri A. Hassan, SCIENCE 5 June 1981:**

"Analysis of Nile flood stages from A.D. 640 to 1921 reveals major episodes of low Nile discharge during the years 930 to 1070 and 1180 to 1350 and major episodes of high Nile floods during 1070 to 1180 and 1350 to 1470. Examination of Nile flood maxima and minima and comparison with water levels in Lake Chad reveal a correlation between high Nile discharge and greater rainfall in equatorial East Africa. There is also apparently a correlation between low Nile discharge and cold climate in Europe." - Abstract.

●

From 'CO_2: Proceed with caution', by Frank Barnaby, The Bulletin of the Atomic Scientists, April 1981:

"an international seminar on 'Carbon Dioxide, Climate and Energy' was held last February in Stockholm at the Beijer Energy Institute of the Royal Swedish Academy of Sciences. The meeting ... stressed time and again how uncertain the experts are about the effects of the increasing amounts of carbon dioxide (CO_2) being injected into the atmosphere, mainly by the burning of coal and oil ..."

"Some computer modelers maintain that a doubling of carbon dioxide in the atmosphere (a possibility within the next 50 years) would increase global temperatures by about 2°C, enough to cause, among other things, great changes in crop yields. 'The rich world would lose and the Third World might gain. The U.S. and Soviet grain belts would be drier, reducing yields. India and the Middle East would be wetter, and Asia could grow more rice. But an end to U.S. grain exports might cause famine - or war.'

...

"It is easy to agree on the urgent need for international action. But it is hard to be optimistic that such action will be forthcoming ... Some countries will see themselves gaining from the greenhouse effect. Others (probably quite a few) may be more than happy at the prospect of the rich North suffering from the climatic, social, economic, and agricultural consequences of a warmer earth.

For subscriptions mail to:
William N. Barbat Associates
P. O. Box 24
Teton Village, WY 83025

Subscription Rates:
☐ Individual or University Library Subscription, 1 year (6 issues).....$20
☐ Company/Institutional/Agency, 1 year (6 issues)
which allows for unlimited "in-house" reproduction rights.....$40

Foreign Airmail add $4 if sent from U.S.

Subscriptions are now available in Europe exclusively through Rudolf Trüb, Cumulus Fachbuchhandlung, 5000 Aarau, Switzerland (Tel. 064-22-50-20 or 22-37-98). The price for one year (6 issues) inclusive of postage is Swiss franks 48.—.

"Be this as it may, the biggest barrier to action, national or international, on the carbon dioxide problem is our lack of knowledge of its effects . . .

"An individual faced with the need to make a decision on the basis of very uncertain information is likely to be cautious. But a group seems to behave very differently in this respect; it usually is not cautious in the face of uncertain information. Quite the contrary. It frequently ignores something which is uncertain, just because it is uncertain.

"And so it is with politicians, especially with politicians. . . . We usually take remedial action only after we are more or less certain of the consequences often after the damage is done.

". . . (B)ureaucracies become incapable of administering anything other than larger and larger technological facilities, even when society would benefit from smaller and less centralized ones . . .

"Politicians often find the large bureaucracies so resistant to change and so politically powerful that they stop trying to control the development of technology. But prudence calls for action to control carbon dioxide. A warmer Earth, we were told at Earthscan's Stockholm seminar, would seriously threaten the North American wheat surplus. Given the global famine which would follow, is this an uncertainty we can afford to ignore?"

Inflation Disrupts the Capital Marketplace

The option of converting from fossil fuels to nuclear energy to halt the CO_2 buildup has been strongly opposed by some writers as being far more costly than the option of reducing energy usage and supplanting fossil fuels solely with solar, wind and biomass.

In 'Energy Strategy for Low Climatic Risks' (Report for the German Federal Environmental Agency, June 1981), Amory B. and Hunter L. lovins, Florentin Krause, and Wilfrid Bach note that "Although the climatological community realizes that prevention of the CO_2 problem is easier than cure, that prevention involves the discipline of energy policy, not of climatology." The authors assert that their study "uses engineering economics to analyze the results of following a 'least-cost engineering strategy' — one that seeks to provide needed energy services at the lowest possible direct economic cost, as would occur in a competitive free market."

Energy reduction has been justified in the report by using Japan as an example. They note that Japan had seven years of growth in real Gross National Product averaging 4% per year with virtually zero energy growth overall. However, in that period ferrous metal production dropped 7% and construction of large merchant vessels dropped 73%, while less energy-consumptive industries such as the manufacturing of computer chips grew rapidly.

In promoting their energy reduction theme, their 'basic menu of efficiency gains for diesel trucks, buses, and cars yields a combined efficiency gain ranging from 78% to 118% (really!). Also they extrapolate to other transports the energy efficiency of a Japanese ship which augments its power with sails to help it achieve a 50% energy saving.

For steelmaking in Europe they propose that iron ore be reduced by charcoal or with electricity from solar power towers or photovoltaics. For electric steelmaking in Japan, they propose using offshore windpower. They propose using substitute materials in place of Portland cement because their system apparently cannot provide process heat cheaply enough to make cement. In order to keep the industrial use of energy from expanding into less developed countries, they employ the rationale, "the extension of the western urban/industrial culture to a global scale would be more likely to represent the imposition of ethnic and cultural biases on Third World peoples than a legitimate meeting of their aspirations for a dignified, autonomous and self-reliant life."

Such schemes as these fail to get adopted for obvious practical reasons. However, the authors and many other people seem to have ruled out the use of nuclear energy entirely (including the proposed abandonment of all the world's operating reactors) rather than to allow nuclear energy to supplant fossil fuels - even if it means defaulting to the CO_2 buildup. The main arguments used against nuclear energy in this report are "reduced nuclear proliferation" (a political problem) and supposedly very high costs. "(T)he soft technologies consistently have lower capital cost, several times lower delivered energy-service price to the final user, than do power plants which would otherwise have to be built to do the same tasks."

The Lovins-Krause-Bach report was prepared for the German Federal Environmental Agency, and the economic and energy supply studies were based on conditions in the Federal Republic of Germany. However, the authors failed to take note of published figures prepared by August-Wilhelm Eitz of the German utility RWE showing the comparative cheapness of nuclear power in FRG under normal circumstances (see the accompanying figure). Yet the authors did refer to a report by energy consultant Charles Komanoff which states that nuclear electricity has lost its overall edge in the U.S., which if not true, is close to the truth. A recent study by a task force composed of officers of the American Nuclear Society found that nuclear electricity is only about 18% cheaper than coal electricity for a plant that goes on line in 1989.

Economic analysis shows that nuclear capital costs have been rising greatly in the U.S. due to governmental budgetary and financial policy, and that these policies threaten to drag down the rest of the world's nuclear industry with it. Because nuclear capital costs are comparatively large, high commercial borrowing rates and government-imposed delays in construction schedules and in permitting the completed reactors to operate destroy nuclear's naturally large economic advantage.

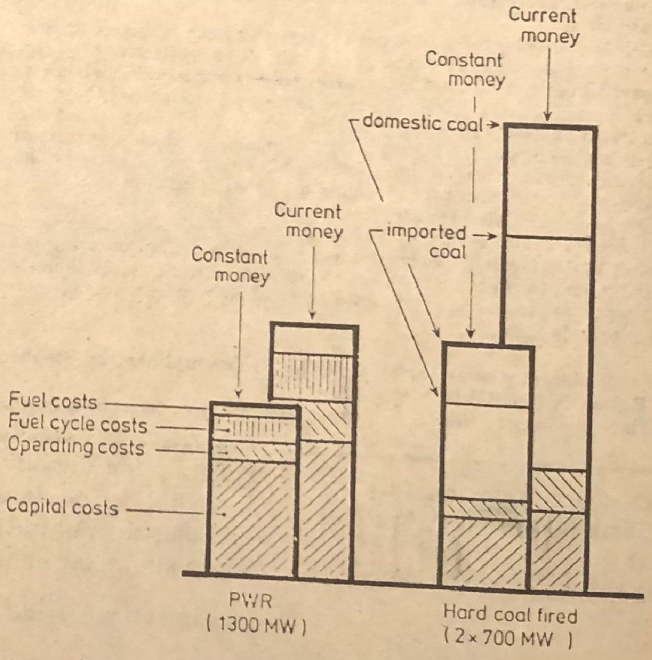
As borrowing rates have climbed, nuclear costs have climbed faster. The decline in all industrial investments for modernizing due to high interest also has resulted in a generally low level of domestic production (and domestic energy consumption) with a rise in imported goods that are made with other countries' energy. Decreased energy projections, as the result, lead to postponed construction that increases nuclear costs further.

In recent months, a technical misapplication of 'monetarism' has broken the normal link between inflation and borrowing rates. The annual inflation rate had dropped in the U.S. from about 15% to less than 10%, while simultaneously the prime bank lending rate to businesses was pushed above 20% by government action. This has created a very high net return over inflation on non-equity investments, which naturally has attracted hard money from all over the world. This swells the money supply, which monetarists react to by raising interest rates even further (a positive feedback). The monetarist fallacy in this case is that an increase in non-hard money (currency dilution) is the standard inflationary signal, not an increase in the country's capital when inflation is under control.

Lenders of foreign governments have expressed much ire at this maintaining of excessively high interest rates in the U.S. because their own interest rates must be raised to avoid a drain of capital.

Thus when Amory Lovins states, "It is the empirical verdict of the capital marketplace...that has rightly sealed the fate of nuclear power," the only debatable point is his choice of the word 'rightly'.

—W.N.B.



Comparison of generating costs of power plants under commercial and licensing conditions of the Federal Republic of Germany, published in *Nuclear News* February 1980.