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Global Energy Futures and the Carbon Dioxide Problem

Gus Speth

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SUMMARY AND RECOMMENDATIONS

Before the Industrial Revolution (about 1800), the atmospheric concentration of CO_2 was about 290 parts per million (ppm). Since then, it has increased an estimated 15-25 percent, and it is known that the concentration has increased about 7 percent between 1958 and 1979.** During the last two centuries, and particularly in the post World War II period, global use of fossil fuels has grown markedly, and the burning of these fuels is believed to have been the principal cause of the increase in atmospheric CO_2. The continued rise in atmospheric CO_2 concentrations poses potentially severe long-term risks to the global climate and to the biological systems that depend on it. Although the overall features of a long-range CO_2-induced global warming are generally well accepted, the timing and, most important, the regional and socioeconomic impacts are not well understood. The analysis presented in this report of the potential risks from even moderate increases in the burning of fossil fuels over the coming decades underscores the

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* *Global Energy Futures and the Carbon Dioxide Problem* was prepared by the President's Council on Environmental Quality of which Gus Speth was Chairman until January 19, 1981. The following is an edited version of the report. Copies of the report in its entirety may be obtained from the Council on Environmental Quality, 722 Jackson Place, N.W., Washington, D.C., or from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

** The present (1979) concentration of CO_2 is about 335 ppm. The pre-industrial level is estimated to lie within the range of 260-300 ppm. This report assumes a pre-industrial level of 292 ppm.

vital need to incorporate the CO_2 issue into the development of U.S. and global energy policy and to accelerate the use of renewable energy sources and energy conservation techniques. This section summarizes the findings of the preceding review and analysis, and offers three recommendations for dealing with the CO_2 problem in a global context.

A. Findings

It is estimated that a doubling of CO_2 in the atmosphere could eventually increase average annual global surface temperatures by about 3°C and by as much as 7°C-10°C in the north polar region during the winter. The possible climatic and socioeconomic effects of such a global warming are discussed in Section I. They include alterations in wind, ocean currents, and precipitation patterns. If large-scale climatic changes occurred, they could lead to major social, economic, and political impacts. These changes would affect both the managed and the less managed biosphere.

If the warming were great enough, and persisted long enough to lead to the disintegration of the West Antarctic ice sheet, ocean levels could rise five to eight meters in several decades, though the time scale is uncertain. This rise would force a gradual evacuation of cities, towns, and the countryside located along coastlines. A five-meter rise in sea level would flood a coastal area of the United States occupied by about 11 million people (5 percent of the population).

Shifts in rainfall could lead to major and disruptive changes in global agricultural patterns. In some regions, agricultural infrastructure could be rendered obsolete, while in other areas increased atmospheric CO_2 and rainfall could benefit agriculture and reduce heating requirements. If agriculture were seriously disrupted in regions that are now productive, major refugee and hunger problems could result unless production increased elsewhere and food could be imported.

The impacts of increased atmospheric CO_2 on the less managed biosphere, although unpredictable in detail, might include shifts in the location and productivity of fisheries, changes in species composition, and the possible extinction of some species with currently unpredictable consequences on ecosystem productivity or resource values for man.

In sum, increased atmospheric CO_2 concentrations could cause widespread and pervasive changes in global climatic, economic, social, and agricultural patterns. The need to adapt to these changes would be placed on a world which is expected to be already heavily burdened with increased political, economic, and environmental troubles in the decades ahead.

In circumstances where the uncertainties are significant, the stakes are high, and the welfare of future generations who cannot participate in current decisions is involved, traditional benefit-cost analysis is of little value. In the United States, the responses to such problems are ultimately fashioned in the political arena where, after public debate of the issues, an informed citizenry has the final say in determining national policy. This report is intended in part to facilitate this national debate by examining the effects of increased atmospheric CO_2.

In light of the risks and potential impacts associated with rising atmospheric CO_2 levels, it is prudent to explore the implications for global energy policy of not exceeding specific long-term CO_2 concentrations. Section II presents this analysis by comparing a number of fossil fuel scenarios that would lead to a 50 or 100 percent increase in atmospheric CO_2 levels.* The scenarios differ in their fossil fuel growth rates over the 1980-1990 period. The calculations indicate that the higher the growth rate over the 1980-1990 period, the earlier the peak in fossil fuel use and the steeper the decline following the peak. For example, in the three scenarios leading to a doubling of CO_2, moderate (2.5 percent) to high (4.0 percent) growth rates in fossil fuel use over the next ten years imply that the decline in the burning of fossil fuels would begin ten to twenty years earlier than if only a modest growth occurred during the upcoming decade.

Thus, the analysis suggests that a low growth rate over the next few decades in the use of fossil fuels, combined with more efficient use of energy, would materially reduce the pressures for rapid societal and technological change later and would allow more time for development of alternative energy sources. Conversely, a rapid increase in fossil fuel use during the next decade could increase the risk of needing to curtail fossil fuel use sooner and more drastically than if the world were to ensure flexibility by beginning now to slow the rate of growth.

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* The model used in this analysis is described in the Appendix and assumes that the curve representing the buildup of CO_2 with time is smooth and continuous (a "logistic" curve).

Furthermore, the analysis underscores the importance of the 2000-2020 time period for fossil fuel use and consequently the utility of undertaking planning and action now if certain levels of atmospheric CO_2 are to be avoided. For example, given the risk involved in increased atmospheric CO_2 concentrations, one possibility is that an international goal be established to prevent a doubling of CO_2 by holding atmospheric CO_2 levels to not much more than a 50 percent increase over the pre-industrial level. If global fossil fuel use grows an average of 2.5 percent per year in the 1980's, achieving this international goal would require global fossil fuel use to peak in the first decade of the next century. Achieving lower rates of growth in fossil fuel use in the 1980's would buy about another decade. Thus, if nations choose to avoid a CO_2 doubling by holding the increase in atmospheric CO_2 concentration to not much more than 50 percent, the 2000-2020 period will mark an historic turning point after which global use of fossil fuels would have to begin a steady decline. 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.

Another implication of the analysis in Section II is that significant amounts of nonfossil fuel energy will be needed if CO_2 levels are to be limited. The amounts needed vary greatly, depending on the concentration to which atmospheric CO_2 is allowed to rise and on world energy demand. The success of efforts to increase energy conservation and efficiency will obviously be a major factor in determining future energy demand.

Although it appears that global CO_2-induced temperature changes may be detectable within ten to twenty years, there is no guarantee that scientists will be able to detect it within this period. Transitory natural compensating cooling effects might occur during this time, thereby masking a global warming. As Section III underscores, if an international response is delayed one or two decades until a CO_2-caused global warming is identified, the world will probably already have significantly increased its reliance on and use of fossil fuels. Economic and institutional factors would make it extremely difficult to reverse the trend, and significant long-lasting climate changes might then be inevitable.

Granted the many uncertainties affecting the magnitude and timing of CO_2-induced climate changes, 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. It is important to assess the possible socioeconomic and climatic implications of a policy permitting such delay.

Coordinated international efforts to limit a global warming trend would likely be extremely difficult and slow. The ramifications of a postponed response to the buildup of CO_2 will depend largely on the climate changes that actually occur. The more rapid and severe the changes, the greater their impacts. Once begun, the climate changes might occur quickly and be very difficult to reverse, particularly if the compensating effects described above are temporarily masking a CO_2 warming. Under conditions of rapid and substantial climate alteration, postponed societal responses — including a rapid reduction in global CO_2 emissions — would have to take place much more quickly than if orderly planning began now. Unless global energy demands were severely cut, these responses may have to include an accelerated phaseout of fossil fuels and the rapid introduction of new energy sources. Historically, it has taken about 100 years for a new energy system to move from 1 percent to 50 percent of total supply. Consequently, 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 thirty to forty year lifetimes. Even if the nations agreed that CO_2 production must be rapidly curtailed, organizing and monitoring a worldwide program would face formidable obstacles.

During the transition toward reduced fossil fuel use — which itself could cause serious socioeconomic disruptions — the climatic effects of elevated CO_2 concentrations might continue to increase. Restoring present atmospheric temperatures might take centuries even if all CO_2 emissions were somehow to stop in the next century. This is because the take-up of CO_2 by the oceans is extremely slow. Furthermore, if the rate of heat absorption by the intermediate ocean layers were greater than expected, then still more heat would have been stored in the oceans before a CO_2-induced warming trend could be detected, and still more CO_2 would have been added to the atmosphere.*

* The climatic complications caused by the ocean's thermal characteristics are the subject

These two factors suggest that if substantial climatic effects were detected, remedial measures might then require many decades to take effect, and long-lasting changes in world climate might then be inevitable. In sum, a failure to take measures now to reduce the risks of CO_2-induced global warming poses real risks of not being able to take effective remedial actions later.

Two important conclusions emerge from the analysis of this report: (i) the potential long-term risks of significant societal disruption caused by increased atmospheric concentrations of CO_2 are real, although the timing and regional impacts are still uncertain, and (ii) if a global response to the CO_2 problem is postponed for a significant time, there may not be time to avoid substantial economic, social, and environmental disruptions once a CO_2-induced warming trend is detected.

Based on present understanding, preserving the option of holding atmospheric CO_2 below 1.5 or 2.0 times the pre-industrial level means that planning for action on an unprecedented global scale would have to begin now. To begin the process of responding, the Council offers the following recommendations to supplement those frequently made elsewhere for a strong, coordinated international research effort exploring all aspects of the CO_2 issue.

B. Recommendations

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

The conclusion seems inescapable that the CO_2 problem should not be isolated from current debate on long-term energy strategy. However, that isolation effectively exists today. The federal government, therefore, should give a high priority to ensuring full consideration of the CO_2 problem in U.S. energy policy and planning. This first step seems prudent in light of the conclusion of a 1980 National Academy of Sciences' panel: "We must recognize now that increases in energy consumption using fossil fuels will have increasingly undesirable climatic effects".

A pressing need in this regard is for sophisticated energy policy analyses focused on the CO_2 issue. Efforts should be started immediately to develop and examine alternative global energy futures

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of active research. If research progress continues, it should be possible within the next few years to provide a much clearer description of how the oceans would affect the dynamics of the temperature response.

with emphasis on regional analysis. These policy analyses should examine the environmental, economic, and social implications of alternative energy futures that involve varying reliance on fossil fuels. Early consideration should also be given to the analysis of: (i) alternative mechanisms and approaches to controlling CO_2 buildup, including international approaches, and (ii) alternative fossil fuel energy mixes, including mixes with more natural gas, which emits less CO_2 per unit of energy than other fossil fuels.

Among the issues that should be addressed in this priority effort, one particularly important question stands out: based on the best available information and analyses, what level of atmospheric CO_2 concentration should be considered a prudent upper bound? The lower the CO_2 limit, the lower the risk of CO_2-induced climatic change, but the greater the near-term social and economic costs. For example, the preferred international goal might be to limit CO_2 buildup to no more than a 50 percent increase over the pre-industrial level. Given current fossil fuel use rates and the world energy situation, avoiding such an increase would be extremely difficult. Indeed, unprecedented international agreement and cooperation would be essential, and vigorous action would need to be taken quickly.

A goal of holding the atmospheric CO_2 concentration to less than twice the pre-industrial level would also be very challenging, but on socioeconomic grounds it would be less costly and more manageable. A CO_2 doubling, however, would pose serious environmental risks. While the uncertainties surrounding these risks are substantial, the risks are real.

Beyond the need for policy analysis, the United States should strive here and abroad to keep open a variety of energy options and not become committed to an extended period of unrestricted fossil fuel use. In part, this recommendation means that the United States should vigorously pursue energy conservation and the development of renewable energy technologies; these issues are discussed below. 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. Coal has an important role in the energy future of the United States and other countries, but its use should proceed here and abroad consistent with the overall need to constrain fossil fuel growth.

Additional attention should also be given to reducing the vulnerability of human settlements and activities to climate changes. Such measures should improve the world's overall ability to respond to natural climate variations, which will occur whether or not atmospheric CO_2 increases. Specific mitigating strategies that reduce vulnerability to climate change include (1) protecting arable land, (2) improving water management, (3) developing and applying improved agrotechnology, (4) improving coastal and land use policies, (5) maintaining global food reserves, (6) providing disaster relief, and (7) preserving genetic diversity.

Finally, the United States should promote global reforestation in order to help offset the CO_2 contribution from the clearing of forests. There are many additional advantages in such a program, quite apart from its role in the wise management of the CO_2 problem.

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

Top priority should be given to increasing energy conservation and the use of solar and other renewable energy sources — both in the United States and abroad. These are energy sources which, except for biomass, do not directly emit CO_2.

In the United States and many other countries, increasing energy productivity is the single most promising means of reducing or limiting CO_2 emissions while providing the energy needed for economic growth. Opportunities for cost-effective energy conservation are abundant, particularly in the developed countries. Developed nations have a special obligation to take advantage of these opportunities in view of the pressing energy needs of most of the less developed nations. Furthermore, energy conservation investments beyond the point of private profitability are appropriate when external or unpriced factors are introduced, such as long-term risks to national security and to the global climate.

The need to accelerate the worldwide use of renewable energy sources is equally urgent and the United States should take a leading role in this effort. If carbon dioxide levels were to be held significantly below a 100 percent increase, nonhydro solar technologies such as wind turbines, active and passive space and water heating, and solar cells will have to begin making major contributions to world energy supply by the year 2000. Because of the long lead times necessary to introduce new energy sources, these contributions can be realized only through an aggressive program whose planning and implementation should begin now.

To this end, it is useful to note that over the last few years the United States has taken several important actions to accelerate the introduction of energy conservation and renewable energy technologies. In June 1979, in the nation's first Presidential Message to Congress on Solar Energy, the President called for a combined effort to achieve a national goal of meeting 20 percent of our energy needs with solar and renewable resources by the end of the century. This goal was set after an intensive federal study of the potential for renewable energy sources in this century. Increased energy efficiency and solar energy are being promoted through actions to price energy at its replacement cost (such as decontrolling oil and natural gas prices), through the establishment of a federal conservation and solar bank, through a program of residential and industrial tax credits, through grants to schools and hospitals, and through an expanded program of conservation audits for residential and commercial buildings. Many studies have documented the fact that national energy efficiency can be significantly increased, thereby reducing energy growth, while sustaining a growing economy. One recent study estimated that conservation policies over the next two decades could lower energy demand in the year 2000 from 116 to 90 quads (a 22 percent reduction) with a loss in the projected GNP for the year 2000 of only 4 percent. Even with this small loss, GNP would almost double between 1977 and 2000.

Impressive as these recent efforts have been, they should be viewed as a starting point. Enhanced efforts to ensure accelerated use of energy conservation and renewable energy technologies are essential both in the United States and abroad.

Although nuclear power is not a direct source of CO_2 emissions, its future is presently clouded by uncertainties regarding the risks of nuclear accidents, the proliferation of nuclear weapons, and the long-term isolation of radio-active wastes. A major commitment to this energy source, burdened with such great uncertainties, could significantly increase the costs and risks to present and future generations. In this respect the expanded use of nuclear power poses problems of potentially major but uncertain risks rivaling those posed by the increase in atmospheric CO_2 from the burning of fossil fuels.

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

Broad, new international cooperative efforts should be undertaken to address issues related to the carbon dioxide problem, and some of the current efforts should be expanded. International collaboration could be particularly helpful in defining the most important issues that would be faced by the developing nations, which comprise about 70 percent of the world's nation-states and population, but account for only about 20 percent of the world's total commercial energy consumption. Over the coming decades, the developing countries will be seeking to increase significantly their use of energy, and they could become the fastest growing sector in the world's energy economy. If high levels of energy efficiency and reliance on renewable energy sources can be incorporated into the economic growth of developing countries, an important part of a global strategy for controlling CO_2 will be advanced. U.S. and international assistance efforts should be consistent with these policies. The Agency for International Development, the World Bank, and the International Energy Agency should consider the CO_2 issue as they assist developing countries in their planning and development.

In this connection, it is useful to note some of the international efforts already underway in which the CO_2 issue is beginning to receive attention. The United Nations Environment Programme has reviewed U.S. program plans and activities and identified several possible cooperative actions. In January 1980 the World Climate Programme was officially inaugurated by the World Meteorological Organization, in collaboration with the International Council of Scientific Unions and the United Nations Environment Programme. An important objective of this international effort is to define the CO_2 influence on climate and the impacts of climate change.

Informal discussions within the European community have begun. In September 1980 the International Energy Agency hosted a meeting of research managers from the Organization for Economic Cooperation and Development nations. The United States has participated actively in planning the CO_2-related programs of the International Institute for Applied Systems Analysis and the International Council of Scientific Unions. Since November 1976, more than ten international meetings have focused on the carbon dioxide problem. At least two more are planned for 1981.

In responding to the global nature of the CO_2 problem, the United States should consider its responsibility to demonstrate a commitment to reducing the risks of inadvertent global climate modification. Because it is the largest single consumer of energy in the world, it is appropriate for the United States to exercise leadership in addressing the CO_2 problem.