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CORPORATE TECHNOLOGY AND SALES

G. H. LONG
Manager

File

February 5, 1981

Atmospheric CO_2
Scoping Study

Ref. No.: 80CNR 171

Messrs. P. J. Lucchesi
R. E. Lyon, Jr.
P. H. Rohr
F. B. Sprow
L. E. Swabb, Jr.

Gentlemen:

Attached for your review and comment is a report on the Atmospheric CO_2 Scoping Study recently conducted by the Contract Research Office. You will recall that scoping studies are the initial phase in the development of comprehensive plans for high-impact programs. The results of the scoping studies are then used as a basis for decisions concerning possible development of high-impact program plans.

Our recommendation is that comprehensive program plan development not be undertaken for the atmospheric CO_2 area. We have concluded that the ER&E projects underway and planned on atmospheric CO_2 R&D are adequate to serve Exxon needs. The current projects were designed to complement Federal CO_2 R&D plans, and examination of recent revisions to the Federal plans indicates that the current Exxon projects remain well-matched with the Federal program. Several other project possibilities were assessed during this study, but they do not appear to offer significantly increased benefits. In addition, the possibility of government funding for projects beyond those currently in the Exxon program is limited since the Government is likely to retain its dependence on national laboratories and universities for CO_2 research.

In addition to continuing the current ER&E research agenda on atmospheric CO_2, we recommend that:

(1) a single point of responsibility be established for collection, interpretation, and dissemination of CO_2 information from Government and industry sources;

(2) more information be developed concerning CO_2 R&D plans and policies of foreign governments; and

(3) developments in the National Climate Program be monitored for their potential impact on the CO_2 R&D program.

The report contains recommendations on assignment of responsibilities in these areas for your consideration.

Following your review, we plan to forward the study results and our recommendation to the President's Office for review.

If you have any questions about the conclusions or content of this report, please feel free to contact Mike Noland, Bob Barnum, or myself.

Very truly yours,

George

G. H. Long

GHL/hz
Att.

c's: Messrs. R. E. Barnum
J. F. Black
M. B. Glaser
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SCOPING STUDY ON CO_2

R. E. Barnum
Contract Research Office
January, 1981

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INTRODUCTION

The increasing level of atmospheric CO_2 is causing considerable concern due to potential climate effects. ER&E has been actively conducting research on certain aspects of the issue for approximately two years. This report addresses the question of whether a comprehensive research plan with greater breadth for ER&E than the current plan should be developed.

This study was felt to be timely because (1) the Federal Government has recently published modified R&D plans on both atmospheric CO_2 and climate, and (2) approximately two years have elapsed since ER&E's plan was conceived.

The conclusions and recommendations from this scoping study are contained in this report, along with descriptions of government and institute R&D, Exxon's projects, and the legislative situation. Text material includes references to source documents for those desiring greater detail.

EXECUTIVE SUMMARY

1. The main conclusion of this study is that the ER&E projects underway and planned on CO_2 are adequate to serve Exxon's needs. These projects:

   - are engaging us directly in technical areas which are critical to resolution of the issue,
   - are providing an opportunity for us to develop a detailed understanding of the total Federal atmospheric CO_2 program which the Corporation needs for its own planning, and
   - if successful, will likely provide recognition for Exxon for making important technical contributions to this global environmental issue.

   An expanded R&D program does not appear to offer significantly increased benefits. It would require skills which are in limited supply, and would require additional funds on the part of Exxon since Government funding appears unlikely.

2. The recommendation is not to proceed with Phase II as described in the Contract Research Management System. Two actions suggested by this study, however, which would improve overall planning are:

   - to establish a single point of responsibility for collection, interpretation, and dissemination of CO_2 information emanating from Government and industry sources, and
   - to develop more specific information on the R&D plans and attitudes of Governments outside the United States in recognition of the fact that atmospheric CO_2 is a global environmental concern.

   Responsibility for these two actions should be assigned to the Contract Research Division of Corporate Research's Technology Feasibility Center with assistance and consulting by the Contract Research Office, Coordination and Planning, and Dr. James Black of Products Research Division.

3. The CO_2 program has been made an element in the recently developed National Climate Program plan. Project plans on CO_2 will therefore become increasingly dependent on how they might contribute to accomplishing the objectives in the climate program area. Dr. James Black has been following developments in the climate area at the Federal level. He will report to the Contract Research Division the Government R&D information and events within the climate area which might specifically impact the Federal CO_2 R&D program. This assumes the assignment to the Contract Research Division of the responsibility for the two actions recommended in number two above.

4. Exxon is an industry leader insofar as involvement in the CO_2 R&D program is concerned. Participation by individual companies other than Exxon appears to be limited to auditing Government meetings on the subject. An API group on CO_2 has been formed in which ER&E is a member.

5. Models are the basis for predictions of climate changes due to an increase in atmospheric CO_2. However, modeling has not reached an advanced stage. In connection with Dr. Black's climate activities, he will keep the Contract Research Division apprised of what the climate modelers are saying about CO_2-induced effects. These predictions will influence the perception of the problem by key groups such as Congress, Federal R&D groups, and the public.

6. The Government is unlikely to shift from reliance in this particular area on universities and Government laboratories to sponsorship of industry program proposals. However, the Department of Energy is expected to react favorably to the current Exxon proposal which suggests joint sponsorship by Exxon and the Government for the work being conducted aboard the Esso Atlantic.

RECOMMENDATION REGARDING COMPREHENSIVE PLAN DEVELOPMENT

The objective of this CO_2 scoping study, which corresponds to Phase I of the Contract Research Management System[1], was to gather and assess information on the issue in order to decide whether to proceed with Phase II. The conclusion reached was that a comprehensive research plan is not justified. This conclusion is based on:

- a reappraisal of the projects selected for our own CO_2 studies in the light of the latest Government CO_2 R&D plans, and
- an estimate of what the benefits might be and who would pay if we were to undertake additional technical projects.

These points are addressed in a later section of the report (pages 10 and 11).

The recommendation, therefore, is not to proceed to Phase II. Information gathering, interpretation, and reporting should continue, however, along with the project work already underway. A conclusion from this scoping study is that more information should be sought on the plans of Governments outside the United States in recognition of the global nature of the CO_2 issue. Consideration should also be given to establishing a focal point for information gathering, interpretation, and reporting.

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(1) Phase I yields the program-specific intelligence report and the conceptual program outline. The intelligence report is designed to be useful to ERE program planning even if program development does not proceed to the strategic development phase.

Phase II generates the strategic program plan for the subject high impact program area. It establishes overall objectives, defines limiting program areas, establishes the several sets of sub-program objectives which must be achieved before the overall program objectives can be realized, identifies and defines the necessary projects, the program logic, project plan, implementation strategy, and program resource requirements.

Phase III involves developing detailed project proposals and plans.

Phase IV involves conduct of the approved projects.

GOVERNMENT AND INSTITUTE R&D PROGRAMS AND PLANS

The "greenhouse effect" has become recognized in recent years as a descriptor for a global warming effect due to build-up of CO_2 in the atmosphere. More specifically, the term connotes an upset in the earth's thermal balance caused by the reabsorption of infrared radiation from the earth by the CO_2 in the atmosphere. An upward trend in CO_2 content is well documented through measurements since 1957 by weather stations of the United States Government. The potential impact on climate concerns many people (1, 2). It forms the justification for a significant technical effort on CO_2.

The Federal expenditures on the CO_2 issue were 14 M$ in the fiscal year just completed. Four principal groups in the Federal Government are involved - the Department of Energy, National Science Foundation, Department of Commerce, and Department of Agriculture. The work is essentially all done by in-house Government laboratories and the academic community. A unique feature of the Government's CO_2 program is that it is one of the few non-nuclear environmental programs in which EPA has not been the prime mover. This role in the case of CO_2 belongs to the environmental group in the Department of Energy, which has been responsible for launching the program and giving it direction and momentum.

The program plan has been evolving since 1977 with the help of DOE-sponsored workshops on the subject (3, 4, 5, 6, 7) and an Advisory Committee on Atmospheric CO_2. Participating in these activities have been personnel from Government, universities, institutes, and environmental groups. The American Association for the Advancement of Science has also been actively involved in conducting a workshop (3) and assembling information. Workshops have also been held in Canada and Europe by other groups.

The second and latest version of the Federal CO_2 R&D plan became available during the period of this scoping study (8, 9). This program and the acid precipitation program, covered in an earlier companion report, are similar in many respects. Both Government programs involve efforts to:

- better establish trends,
- understand the physical and chemical processes involved,
- identify the contribution of nature as well as man to these problems,
- develop improved models, and
- fill in many information gaps related to such things as agricultural impacts, aquatic effects, etc.

Both programs will involve major R&D efforts throughout the 1980s.

The goal of the atmospheric CO_2 program is to:

> "develop the ability to predict agricultural, environmental, and societal consequences, both national and international, of increasing atmospheric concentrations of carbon dioxide with sufficient confidence to permit informed policy decisions to be made on the use and development of energy and other resources."

A diagram showing program elements and their inter-relationships is given on page 6. Uncertainties lie in four principal areas: sources of carbon dioxide; the global carbon cycle; the timing, magnitude, and global distribution of climate changes; and socioeconomic impacts.

Answers to the following questions are being sought in order to evaluate possible courses of action:

- What will be the future atmospheric concentrations of CO_2 for various scenarios of carbon dioxide releases to the atmosphere?
- What will be the climatic response to these elevated CO_2 concentrations?
- How will these climate changes, along with the increased CO_2 concentrations, affect the geological and physical environments?
- What, if any, will be the effects of these changes on human societies?
- In the event these changes are undesirable, what actions can be taken to prevent or counteract them? Or to improve adaptation to them? If the changes are locally beneficial, how can these regions be identified?

Emphasis at present is on the first two of these five questions. Key dates in the program are 1984, when an interim assessment of the problem is scheduled, and 1989, at which time a full report is to be made by DOE to the "policy community" (executive, Congress, and public).

Neither the Electric Power Research Institute nor the Gas Research Institute are significantly involved in CO_2 R&D at the present time.

At present, international leadership is shared by the International Council of Scientific Unions (ICSU), representing the academic world, and the World Meteorological Organization (WMO), representing the Governments. Since 1976, more than ten international meetings have focused on the carbon dioxide problem. A special working group on carbon dioxide exists in WMO. CO_2 research is also carried out by national Governments such as the Federal Republic of Germany, Australia, and Sweden. The plans of these groups should be obtained in future monitoring of CO_2 work. This scoping study indicates, however, that a special effort will be required to acquire them.

A NATIONAL PROGRAM ON CARBON DIOXIDE, ENVIRONMENT AND SOCIETY

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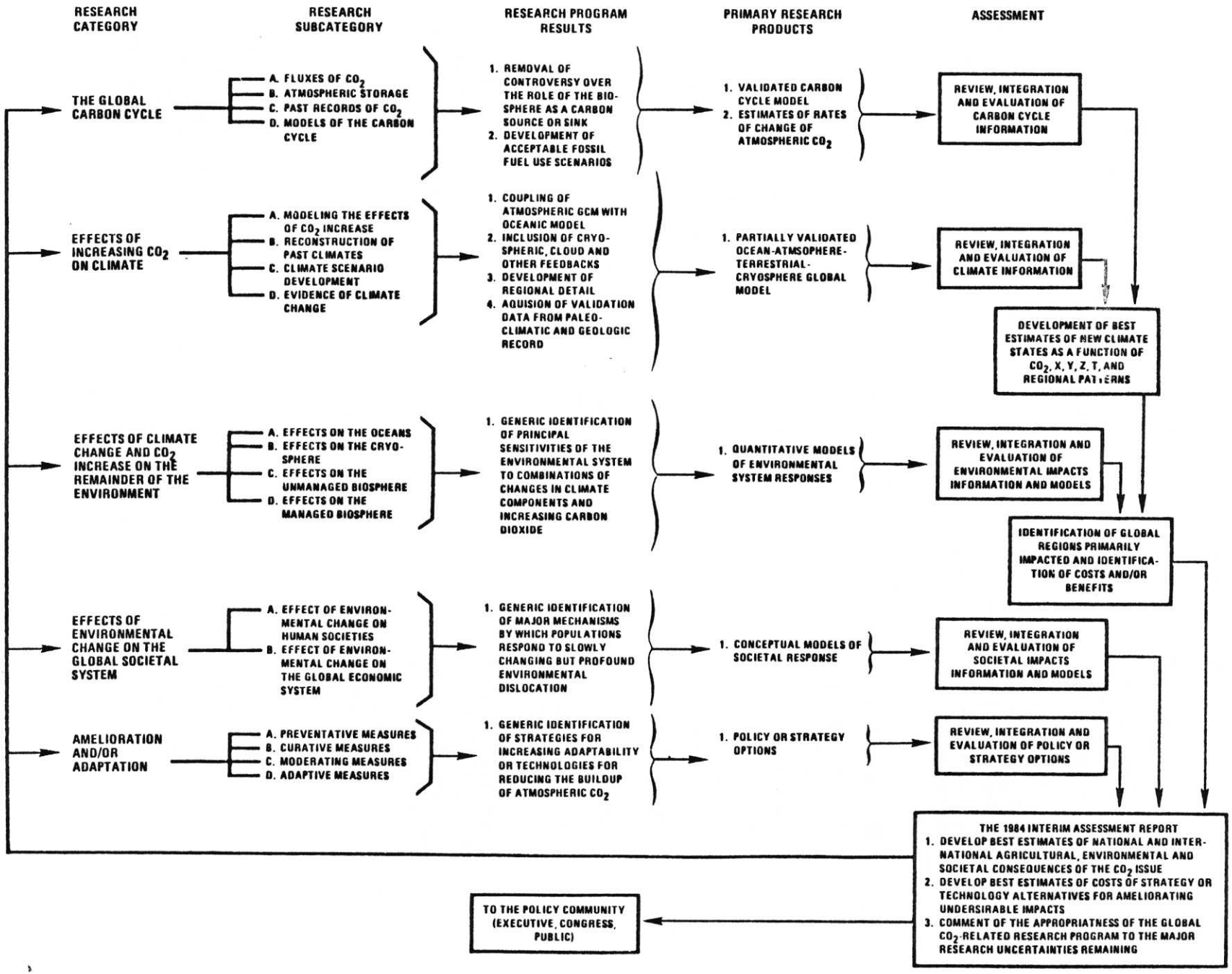

The Federal research program on CO_2 is now integrated into the National Climate Program being administered by NOAA. This program was developed in response to the National Climate Program Act of 1978 (P.L. 95-367). The total funding in FY'80 for the National Climate Program was 115 M$. In the fiscal year just begun, the support for climate research will probably increase about 10% over 1980. The objectives of the program are to more effectively organize the Federal Government's efforts on climate research, improve forecasting, and determine effects on agriculture, water, and other areas. The activity will have a significant effect on the CO_2 program and will be monitored. Climate program information is contained in References 10, 11, and 12.

Discussions held with officials in the Department of Energy and the Council of Environmental Quality as part of this scoping study are documented in References 13 and 14.

EXXON TECHNICAL PROJECTS RELATED TO CO_2

ER&E's atmospheric CO_2 program was launched approximately two years ago following an assessment in which a number of project possibilities were considered (15, 16, 17, 18, and 19). The rationale for Exxon's involvement, as stated in the program recommendation to the ER&E Management Council (20), was to:

- make an early assessment of the possible impact of the greenhouse effect on Exxon's Business,
- form a responsible team that can credibly carry bad news, if any, to the Corporation,
- develop expertise to evaluate Government programs,
- provide the Government with high quality information to reduce the business risk of poorly formulated Government policy, and
- generate important scientific information that will enhance the Exxon image and provide public relations value.

Additional background is contained in a letter from E. E. David to G. T. Piercy (21), in a proposal now pending with the Department of Energy (22), and in a handout used in a meeting with Exxon's Gas Department on December 3, 1980 (23). The technical activity on CO_2 is being carried out in ER&E's Corporate Science Laboratory (Technology Feasibility Center).

The ER&E projects are aimed at helping to resolve the roles of the world's oceans and forests in establishing the global carbon balance. The projects were chosen based on the known high priority given in the Government's program to these particular technical areas and our perceived ability to provide some unique capabilities and innovative approaches. Two of the projects (one of which has not yet been activated) deal with obtaining information which will primarily serve to estimate the net global CO_2 flux into the ocean. This knowledge is important because the rate data affect the residual atmospheric CO_2 accumulation. The results are needed to develop improved models for making future projections. The third project will help establish the relative annual contribution of fossil fuel combustion and of forest clearing to the atmospheric CO_2 inventory.

The major portion of Exxon's expenditures to date relates to one of the two Exxon ocean sampling projects. This involves sampling the Indian and Atlantic Oceans from on-board the tanker Esso Atlantic. A computer-controlled CO_2 measurement system has been developed and installed on-board the tanker. In addition to simultaneous ocean and atmospheric CO_2 sampling, other data which are critical to understanding the dynamics of mixing in the ocean will be obtained. This will eventually involve continuous measurement of gases such as N_2O and CH_4 using a gas chromatograph and determination of C^{14}/C^{12} ratio in the CO_2 dissolved in the surface ocean water.

The second ocean sampling project will involve measuring the mass transfer coefficient at the air/sea interface as a function of weather conditions and sea state using naturally occurring radon-222 as a tracer. This will involve working from drilling ships. This project will likely start in 1981.

The third project involves an innovative approach to studying the relative contribution of fossil fuel and forest clearing to the CO_2 atmospheric inventory. Carbon-14 measurements will be made on wines of varying vintage in order to estimate the composition of the atmosphere that existed at the time when the wine was made. Carbon-14 presence in the wine can be attributed to photosynthesis effects since Carbon-14 is virtually absent from fossil fuels. The project was initiated in 1980.

Exxon appears to be an industry leader insofar as involvement in the CO_2 R&D program is concerned. Participation by individual companies appears to be limited to auditing Government meetings on the subject. The American Petroleum Institute has established a small study group on CO_2 on which ER&E is represented. However, no formal proposal for work has been developed as yet. The International Chamber of Commerce is considering the development of a position paper on the subject.

KEY QUESTIONS IN ASSESSING NEED AND BENEFITS FOR PHASE II

Three questions were regarded to be of prime importance in assessing the desirability of moving into Phase II with this study. These questions were as follows:

- are the projects selected for ER&E's own CO_2 work still appropriate in the light of known changes in the Federal R&D program,
- are there still other technical questions we should do research on, and
- assuming new projects were conceived in a Phase II, what would be the prospects for funding by the Federal Government?

Little benefit to moving to Phase II was apparent when answers were formulated to these questions.

In considering the first of these questions, the latest Federal atmospheric CO_2 plan was compared in detail to the plan published earlier. The logic in making this comparison was that the Exxon projects were originally selected to complement the projects in the Government's own program and the intent was to openly exchange information and perhaps share costs. The changes made in the Government's plan since the Exxon program was conceived were not found to be of major consequence. Therefore, it was concluded that there is no need to modify our existing project plans.

The situation was also analyzed from the standpoint of whether to expand the number of projects in ER&E's plan. The Federal plan on CO_2 was used to survey the various possibilities since it contains a complete set of projects necessary to the resolution of the questions on CO_2. The one area which initially looked attractive in this assessment was participation in development work on improved models to predict temperature increases due to CO_2 build-up in the atmosphere. These predictions govern the perception which key groups have of the seriousness of the problem. Many groups are working in this area under Government sponsorship. However, modeling has not reached an advanced stage of development. Unfortunately, in order to make significant technical contributions to the modeling area, Exxon would have to develop skills which are in limited supply. The conclusion, therefore, was that the probability is low that a detailed planning effort such as Phase II would lead to additional attractive projects to add to what is already planned.

The final question is somewhat academic in the light of the answers to the first two questions, but the answer nevertheless is instructive. The question was aimed at who would have to be the funding

source - Exxon or the Government? Discussions were held with the Government program planners and also the Federal budget funding trends were reviewed. The results clearly indicate that the Government is unlikely to fund any new projects with Exxon beyond the proposal currently pending. There are two reasons for this:

- the tightening up of the Federal budgets, and
- Exxon competition with the academic community for contract funds.

The costs of additional projects would, therefore, accrue to the Corporation. Inasmuch as Exxon is already heavily committed financially, further consideration of additional projects does not appear worthwhile.

LEGISLATIVE SITUATION

The legislative situation concerning atmospheric CO_2 has been reviewed from two aspects. The first is legislation as it relates to CO_2 control for environmental reasons. The second is legislation relating to the technical activity itself.

Legislation Related to CO_2 Controls

There is no near term threat of legislation to control CO_2. One reason for this is that it has not yet been proven that the increases in atmospheric CO_2 constitute a serious problem that requires immediate action. In addition, even if some action were to be taken, the options for reducing CO_2 build-up in the atmosphere are relatively limited. It has been shown, for example, that the cost of scrubbing large quantities of CO_2 from flue gases is exorbitant (24, 25). Indirect control measures, such as energy conservation or shifting to renewable energy sources, represent the only options that might make sense.

The time at which consideration might be given to some specific legislative action is difficult to predict. It will depend on such things as (1) attitudes of the new administration, the new Congress, and the public, (2) the impact that any legislation might have on the energy supply situation, and (3) the technical information being developed in the various programs. The CO_2 issue has already been the subject of discussion at Congressional hearings, a workshop of the National Commission on Air Quality, and a recent special report by the Council on Environmental Quality (26, 27, 28 and 29). A date of some significance in this developing picture is 1984. This is the point in the Federal CO_2 R&D program when an interim assessment report is due to the "policy community" (executive, Congress, and the public). Much work of a highly technical nature will be required in the interim to fill in the information gaps that exist on the global carbon cycle, effects of CO_2 on climate, and effects of climate on the remainder of the environment.

Legislation Affecting R&D

The Office of Science & Technology Policy and the National Academy of Sciences are to carry out a comprehensive study of the projected impact of fossil fuel combustion, coal conversion and related synthetic fuels activities on the level of CO_2 in the atmosphere. The aim is to develop an international, world-wide assessment of the problems involved and to suggest whatever research seems appropriate to resolve these problems. This study, which is due in mid-1984 at the latest, will have a major impact on the technical program to follow. The desirability for ER&E to monitor developments on this study and input to the study is obvious.

This joint study is mandated in the Energy Security Act passed earlier this year. A copy of the pertinent section dealing with this study is provided in Appendix A. The new administration would be expected to have an impact on the approach which is taken in the study.

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APPENDIX A

TITLE VII OF ENERGY SECURITY ACT

Subtitle B—Carbon Dioxide

STUDY

SEC. 711. (a)(1) The Director of the Office of Science and Technology Policy shall enter into an agreement with the National Academy of Sciences to carry out a comprehensive study of the projected impact, on the level of carbon dioxide in the atmosphere, of fossil fuel combustion, coal-conversion and related synthetic fuels activities authorized in this Act, and other sources. Such study should also include an assessment of the economic, physical, climatic, and social effects of such impacts. In conducting such study the Office and the Academy are encouraged to work with domestic and foreign governmental and non-governmental entities, and international entities, so as to develop an international, worldwide assessment of the problems involved and to suggest such original research on any aspect of such problems as the Academy deems necessary.

(2) The President shall report to the Congress within six months after the date of the enactment of this Act regarding the status of the Office's negotiations to implement the study required under this section.

(b) A report including the major findings and recommendations resulting from the study required under this section shall be submitted to the Congress by the Office and the Academy not later than three years after the date of the enactment of this Act. The Academy contribution to such report shall not be subject to any prior clearance or review, nor shall any prior clearance or conditions be imposed on the Academy as part of the agreement made by the Office with the Academy under this section. Such report shall in any event include recommendations regarding—

(1) how a long-term program of domestic and international research, monitoring, modeling, and assessment of the causes and effects of varying levels of atmospheric carbon dioxide should be structured, including comments by the Office of the interagency requirements of such a program and comments by the Secretary of State on the international agreements required to carry out such a program;

(2) how the United States can best play a role in the development of such a long-term program on an international basis;

(3) what domestic resources should be made available to such a program;

(4) how the ongoing United States Government carbon dioxide assessment program should be modified so as to be of increased utility in providing information and recommendations of the highest possible value to government policy makers; and

(5) the need for periodic reports to the Congress in conjunction with any long-term program the Office and the Academy may recommend under this section.

(c) The Secretary of Energy, the Secretary of Commerce, the Administrator of the Environmental Protection Agency, and the Director of the National Science Foundation shall furnish to the Office or the Academy upon request any information which the Office or the Academy determines to be necessary for purposes of conducting the study required by this section.

(d) The Office shall provide a separate assessment of the interagency requirements to implement a comprehensive program of the type described in the third sentence of subsection (b).

AUTHORIZATION OF APPROPRIATIONS

SEC. 712. For the expenses of carrying out the carbon dioxide study authorized by section 711 (as determined by the Office of Science and Technology Policy) there are authorized to be appropriated such sums, not exceeding $3,000,000 in the aggregate, as may be necessary. At least 80 percent of any amounts appropriated pursuant to the preceding sentence shall be provided to the National Academy of Sciences.