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ALCOHOL FUELS POLICY

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ENERGY

OF THE

JOINT ECONOMIC COMMITTEE

CONGRESS OF THE UNITED STATES

NINETY-SIXTH CONGRESS

SECOND SESSION

PART 2—Potential for Renewable Resource Alcohol Fuels

JUNE 25, 1980

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PART 2—POTENTIAL FOR RENEWABLE RESOURCE ALCOHOL FUELS

WEDNESDAY, JUNE 25, 1980

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ENERGY
OF THE JOINT ECONOMIC COMMITTEE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:05 a.m., in room 6226, Dirksen Senate Office Building, Hon. George McGovern (member of the subcommittee) presiding.

Present: Senator McGovern and Representative Bedell.

Also present: Mayanne Karmin and Philip B. McMartin, professional staff members; and Betty Maddox, administrative assistant.

OPENING STATEMENT OF SENATOR MCGOVERN, PRESIDING

Senator MCGOVERN. If we could come to order now I think we will open the hearing.

The Nation's security in terms of its ability to meet demands for food and fiber as well as the economic future of the American farm and rural America as a whole will be largely determined by the way in which the Federal Government answers the policy questions that we are going to be looking at in this hearing today.

Those questions are: Will the Government commit itself to full-fledged production of farm-based alcohol fuels as a part of a balanced alternative energy program? If so, will our family farmers and local owners in rural community production facilities be given the opportunity to make a maximum contribution to that kind of a program? Or, will giant oil and other huge energy conglomerates be allowed to totally control alcohol fuel because of the lack of a sound Government policy committed to small-scale production and marketing?

The answers to these questions remain hidden behind a cloud of confusion and uncertainty that I hope we can penetrate this morning.

A green policy light for small-scale alcohol fuel production means that an enormously important chapter will unfold in the Nation's farming sector. Individual farmers could erase their dependence on oil. A major on-farm and rural community renewable resource industry, operating in harmony with the production of adequate food and fiber, could be quickly established across the Nation. American farmers could lift themselves above the income subsistence level to which they are chained by present market conditions.

Hundreds of thousands of new jobs could be created throughout rural America because of the existence of locally produced and locally controlled alcohol and other renewable resource fuels. The Nation would have a yardstick by which to measure the cost and availability of alternative fuel produced by big energy companies.

I have been traveling very extensively to every part of my State in the last few months and I have never found a time when farmers were more concerned about their own economic future than they are right now. One of the reasons is because of their heavy dependence on escalating energy prices. Whether the Federal Government develops and implements the policy to attain these goals remains in doubt.

With two sharply conflicting sets of alcohol fuels policy recommendations facing him, the Secretary of Energy has thus far failed to articulate a clear and comprehensive policy.

In what I view as an appalling case of distortion and bias, the Secretary has been presented with a report from the Department's Energy Research Advisory Board that finds that the potential for farm-based alcohol fuels must be limited to an absurd production level of 800 million to 900 million gallons a year in order, according to the Commission, to prevent disruption of food and fiber supplies. At the very least, that report is burdened by the appearance of serious conflict of interest. Two of the key persons who were instrumental in developing its findings and recommendations have ties to the Mobil Oil Corp., which has spent millions of its own and taxpayers' dollars to develop a process to convert coal-derived methanol alcohol to synthetic gasoline.

That process is years away from utilization and carries with it as yet unsolved pollution problems. I don't think anybody disputes that.

Acting at the Secretary's request to evaluate the Advisory Board's effort, the Energy Department's Office of Alcohol Fuels has completed a draft report which finds that more than 2 billion gallons of alcohol fuels a year can be produced in farm resources without in any way jeopardizing food supplies.

The significance of that figure is made clear when it is realized that this will more than replace all of the gasoline product that this Nation now imports from abroad. Moreover, the Alcohol Fuels Office in the Department of Energy is convinced that the quickest way to achieve initial significant alcohol production is through the relatively inexpensive and fast construction of efficient small-scale facilities.

Now, to his credit, the Secretary of the Department of Energy has indicated a reluctance to buy the recommendations of the Advisory Board. I commend him for that. But his failure to announce and implement a sound and comprehensive alcohol fuels policy giving a full participatory role to small-scale production perpetuates this policy vacuum. Under these circumstances, farmers are deprived of access to vital capital at reasonable costs and on-farm or rural community production of alcohol fuels is being held to a very small and inadequate level.

Absent any change, we can look forward to an alcohol fuel industry comprised of big oil and other energy companies which will subordinate production and distribution of this alternative energy to their main business of selling petroleum products. I have no doubt they will

unhesitatingly peg the price of alcohol fuel to the ever-rising cost of oil.

American farmers attempting to sell grain and other crops for alcohol fuels production will find themselves the captives of these big companies in much the same way that they are now the captives of big grain dealers. So the promise of a new economic era for rural America will have been snatched away and family farmers, the backbone of our agricultural industry all across this Nation, will be forced to continue their chronic and losing struggle to survive.

The alcohol fuels policy battle has been openly joined by Mobil Oil which has publicly rushed to the defense of Mr. Paul Weisz, the manager of its central research division, and Mr. David Pimentel, professor at the Cornell University College of Agriculture, who has acted as the paid consultant on alcohol fuel to Mobil Oil. Mr. Weisz was a member and Mr. Pimentel was the chairman of the group which developed the Advisory Board recommendations for the Energy Department.

To my dismay, they have been allowed to assume these same positions on the Department's newly formed biomass panel which will also address alcohol fuels policy.

In defending Mr. Weisz and Mr. Pimentel, Mobil has attacked columnist Jack Anderson; has attacked Mr. Barry Commoner, a distinguished scientist; and attacked me as the presiding chairman of this committee, on the ground that we are unqualified to criticize the report either because we are not scientists or because we are standing for public office. According to Mobil, only scientists who are not in public life can be privileged to know the truth.

I want to make it clear that we invited the Mobil Oil Co. to have their representatives here to testify and to give their side of this argument, which I thought was only fair, although they have presented that side in paid advertisements in the press. We wanted to give them an opportunity to do it at this hearing. The company declined on the grounds that Mr. Weisz is in China. Thus he will miss the opportunity of wearing two hats, one as an employee of Mobil which has a direct stake in the issue at hand, and the other as a company-described objective adviser.

The only other person Mobil thought qualified to testify is in West Germany this morning apparently working on a Mobil synthetic gasoline project thereon which the Energy Department so far has invested some $10 million in public funds.

So let us get on with our search in this hearing today for a true and adequate alcohol fuels policy or at least one that comes closer to the truth than Mobil Oil would allow us.

Well, I think that's enough for an opening statement. I want to welcome Congressman Bedell of Iowa to this hearing. Nobody in the Congress has worked any harder or with any more imagination to develop an intelligent alternative fuels policy and one that would strengthen not only the farmers of America but benefit all the consumers of the Nation as well. I'm happy that he's here.

I don't know, Congressman, whether if you have an opening statement you wanted to make or not.

Opening Statement of Representative Bedell

Representative Bedell. Just a short one, if I might, Senator.

First of all, I would like to thank you for your leadership in this effort. I want to thank Mrs. Smith who's here to testify for her involvement in it, and I guess I really want to thank the ERAB board because I believe they brought to our attention something that we probably would not have focused on if it had not been for this particular report.

In my opinion, the question goes way beyond whether gasohol is a good product, whether it's economic to produce ethanol at this time. Those answers are going to be answered by my farmers in northwest Iowa and Mrs. Smith's farmers and the Senator's farmers. Indeed, they are already making alcohol.

The important thing it that it appears to me that the ERAB report has alerted us to a question, and that question is: Who is it that's making policy in the Department of Energy? The real question is: Are the people in the Department of Energy making policy as it is dictated by Mobil Oil and other large suppliers of energy at this time, or are they there to represent the problems that our society faces and the problems of our taxpayers?

I don't blame the Secretary of Energy. I think the Secretary of Energy has come into a new position. Certainly, so far, indications to me have been that he does have an interest in alcohol fuels, but I believe we'd better look at exactly why it is that when a group of only seven people were appointed to look at this issue, one of them was an actual employee of Mobil Oil, who not only has clearly stated their opposition to this sort of thing who has a private reason for not wanting to see other alternative forms of energy because of a patent they hold on a process of converting methanol alcohol over to high octane gasoline, which as the Senator has already indicated, has been to a large extent financed by the taxpayers of the United States, and I want to get into those contracts if we possibly can as we get into this hearing.

I believe that you are aware of the ads they have been running. I assume those ads are deducted from their expenses as a legitimate expense, yet they still have in the last quarter, over a billion dollars of profits in their operation. I question a little bit whether is should be proper for Mobil Oil to be able to attack politicians as they say in their article, but it would not be possible for Senator McGovern or myself or anybody else to run a similar ad and deduct that as an expense.

So I think we have to look at exactly what our system is and who's operating it and what the national interests are, and for that reason I am not only thankful to you, Senator and Mrs. Smith, but I'm thankful to ERAB. I think they have exposed a problem that somebody had better look at and better decide how we proceed in the best national interest, and who it is who really controls what is done in regard to our energy policy here in the United States.

Senator McGovern. Thank you, Congressman Bedell.

Our first witness is Congresswoman Virginia Smith of Nebraska. Representative Smith, we are delighted to welcome you to the subcommittee and I hope after you make your statement that you will be

able to join us at the dais and further participate in the hearing, if your schedule will so allow. I'm going to ask the rest of the witnesses today, because of the time constraints we're operating under, to try to limit their statements to about 10 minutes and then we will insert the entire prepared statement in the printed record.

You can proceed in any way to see fit, Representative Smith. We welcome you to the subcommittee.

STATEMENT OF HON. VIRGINIA SMITH, A U.S. REPRESENTATIVE IN CONGRESS FROM THE THIRD CONGRESSIONAL DISTRICT OF THE STATE OF NEBRASKA

Representative SMITH. Thank you, Senator McGovern.

I want to commend you for calling this hearing to publicly explore the charges of abuse of power aimed at seriously impeding an effective Federal effort for gasohol. It appears that this most influential of scientific panels of the DOE has been used as a kangeroo court to lend credibility to former Under Secretary John Deutch's well-known opposition to gasohol.

After a long meeting recently with Secretary Duncan, I am more concerned than ever. He has failed to answer a series of questions that I asked him concerning this operation, although I'm used to that. I haven't yet had an answer to a letter that I sent to him on the 15th of February.

You know, Senator McGovern, I think advisory boards are a good thing. It sounds fine to get unprejudiced and knowledgeable people from out across the country to counsel and advise us here in Washington. But when these people are used as a propaganda vehicle to lend credence to the prejudices of politically appointed bureaucrats, then I think the Congress has a responsibility to look into the matter, especially those of us on the House Appropriations Subcommittee on Energy.

The Energy Research Advisory Committee spent $200,000 2 years ago. This year they will spend more than $500,000; and now they are asking us for almost $1 million.

We are all aware that the Department of Energy just a short time ago completed a long and comprehensive study of alcohol fuels conducted by the top Department of Energy officials. Very shortly after that the Under Secretary, Mr. Deutch, had a key role in convening this gasohol study group, composed of seven people. As you have pointed out, two represented Mobil Oil, and I think you outlined their specific interests; two represented Georgia Tech where their chief interest was wood—one of those two, Dr. Stelson, appeared before our House Energy Subcommittee and made it very clear that he had little knowedge of or interest in gasohol. On that seven-member panel was one person who really understood gasohol and was pro-alcohol fuels, and that was Mr. Scheller who happens to be from my home State of Nebraska.

This panel was hastily convened. It was not publicly announced. The first meeting was on December 10. No recording was kept of what happened at the meeting. The second day, December 11, on the objection of some DOE officials, they did keep a record of what happened, and the very next day the report was written by the chairman

of the gasohol study group who got the approval of the other members by telephone. Mr. Scheller, the one who was an alcohol expert, was told on the phone that there was no way provided for him to file a minority report. So he was really left out.

And then, absolutely against the Federal Advisory Committee Act, they went directly with these recommendations to a top Energy official when the act requires this be done only by the full ERAB Board, and the top Energy official made use of them and soon the recommendations were used by the public.

Now on May 22, with the full authority of the chairman of the Energy and Water Subcommittee, I asked the staff to investigate the questionable circumstances surrounding the development of an anti-gasohol report by the Energy Research Advisory Board—the most influential of the scientist advisory boards in DOE. I was particularly concerned by the decision to launch another gasohol study just a few months after another lengthy and comprehensive study. I was concerned by the decision to appoint two scientists from Mobil Oil. I was concerned by the indication that this apparently superfluous and biased study group had been wrongfully convened by top DOE officials to provide ammunition to shoot down congressional plans to promote gasohol as an alternative fuel.

Although the staff was armed with a letter from the subcommittee chairman to the Secretary of Energy, Mr. Duncan, requesting full access to documents, they were put off and were almost unable to get the documents and still haven't gotten all of them.

However, despite this obstruction of our investigation, the staff did obtain some internal DOE files and oral statements from DOE officials that indicate a top DOE official misused the Department's most official scientific panel to add credibility to his own preconceived position in favor of methanol fuel. Before the study group was convened, then Under Secretary Deutch was known to be an advocate of methanol and an opponent of increased gasohol production. He made these views known on a number of occasions.

The study group was assigned to virtually duplicate the report by the Alcohol Fuels Policy Review Committee which reached conclusions that did not support former Under Secretary Deutch's position. One seat on that seven-member gasohol study group appears to have been reserved for a representative of Mobil. According to handwritten notes in ERAB files, first to be considered was Paul Weisz, Manager of Control Research and Development, and then apparently suggested as alternate choices were J. R. White, and John McCullough. I would like to submit copies of these notes for the record. It appears from handwrittten notes that Mr. Pimentel, the Mobil consultant who chaired the group, recommended these Mobil scientists.

However, the Mobil advertisement which appeared in recent issues of the New York Times, the Washington Post, and the Washington Star claims that Deutch himself appointed Paul Weisz of Mobil, which is in clear violation of the Federal Advisory Committee Act.

Now Prof. David Pimentel, the chairman of the Gasohol Study Group, worked directly with both Weisz and McCullough when he consulted for Mobil, but Pimentel did not make his relationship known to other members of the Gasohol Study Group or to ERAB until a February ERAB meeting 4 months after he accepted the Gasohol

Study Group chairmanship and 3 months after he had drafted the gasohol report. He finally acknowledged his association with Mobil and these Mobil scientists after the connection was revealed to E. Stevens Potts, an assistant to Charles Duncan, sometime in January. Pimentel failed to report his Mobil consultancy when he filed his "bias statement,"—conflict of interest report—with DOE. In fact, when the staff requested the bias statements of ERAB and the study group members, the DOE could only produce bias statements for 16 of the 25 ERAB members, none for the Gasohol Study Group, and only 2 of the 9 chosen for the biomass panel. The others had failed to file.

Without these statements, Department of Energy officials have no way to determine the sources of bias of the information they received.

Now these reserved corporate seats go beyond the Gasohol Study Group and raise serious questions about whether board members are selected for their personal expertise or for their corporate connections.

Former Under Secretary Deutch did not wait for a final report on the Gasohol Study Group's findings to be approved by ERAB before firing off a memo to DOE Secretary Duncan with negative recommendations for the gasohol program.

The Federal Advisory Committee Act prohibits study groups from making recommendations directly to Department officials before these recommendations receive full approval of the parent advisory board. But despite the prohibition, the Gasohol Study Group members briefed Deutch who used their preliminary and unsanctioned findings to support his antigasohol views.

This apparent campaign to derail the gasohol program was halted by President Carter's decision to endorse gasohol development. On January 11, 1980, shortly after the Soviet grain embargo and before the January Iowa caucuses, President Carter announced a massive gasohol program. Were it not for the President's actions, the Under Secretary, with the support of ERAB, might have succeeded in gutting the whole gasohol program.

The negative findings of the Gasohol Study Group were strongly disputed by E. Stevens Potts, then Acting Director of the Office of Alcohol Fuels, in a memorandum to Secretary Duncan on May 1, 1980. He attacked both the study group's objectivity and competence and recommended to Duncan that he disavow the study group's findings.

I would like to submit a copy of this memo for the record.

Secretary Duncan, however, all but ignored Potts' recommendations and instead lavished praise on the ERAB in a letter to the ERAB chairman on May 7, 1980, and I will, with your permission, submit a copy of that letter for the record.

Also, Deputy Secretary of Energy, John Sawhill, went out of his way to apologize to the Board for the Potts memo at a May ERAB meeting.

Now finally, the new ERAB Biomass Panel has many of the same problems that the Gasohol Study Group did, including the same members with Mobil ties. Members of Congress, officials of DOE's Consumer and Alcohol Fuels Offices and concerned citizens objected to the unbalanced makeup of the Gasohol Study Group. But despite this

outrage over what was perceived as a biased panel, five of the seven Gasohol Study Group members have been reappointed to a new nine-member ERAB Biomass Panel. Mr. Pimentel will again be chairman and Paul Weisz of Mobil has been named as a panel member. The Biomass Panel will study alternate fuels, including, of course, gasohol, and it's interesting to note that the one pro-gasohol member of the Gasohol Study Group, Mr. Scheller, was omitted from this group. I have already been told by top DOE officials that the biomass subgroup will not change the findings and conclusions on gasohol because it would be an embarrassing admission that they were wrong the first time.

Senator McGovern, the apparent lack of concern for the objections of DOE staff, Members of Congress, and concerned citizens pervasive throughout this entire debate is inexcusable. From the unanswered letters to the formation of a biomass panel with virtually the same membership as the Gasohol Study Group, both the DOE and the ERAB seem unconcerned with what some of us see as grave problems. In light of the current series in the Washington Post on Government contracting abuses, I think it is evident that we need to exercise extreme care when the U.S. Government solicits advice from private corporations or their employees, or from universities and consulting firms. I reject the argument that this investigation and this hearing are attempts to capitalize on popular sentiment by attacking a large oil company. My colleagues and I are rightfully concerned about the highly regarded advice received by the Department of Energy and how that advice is being used. I hope we all have the same ultimate objective in mind—a sound, constructive energy policy that will lead us away from our suicidal dependence upon foreign oil sources. Without complete utilization of all practical energy sources, this will be impossible. Without fair, objective analysis, unobstructed by corporate interest or bureaucrats' personal interests, it will be impossible to determine what all these available sources of energy are.

I thank you, Senator, and I regret I cannot accept your invitation to join the panel because I have an important issue on the floor in which I must participate, but thank you for this privilege.

[The prepared statement of Representative Smith, together with additional material for the hearing record, follows:]

PREPARED STATEMENT OF HON. VIRGINIA SMITH

Mr. Chairman, members of the subcommittee, I first want to thank and commend you for holding these important hearings at this time to not only explore the progress of the Administration the President's goals for gasohol, but also to publicly explore the charges of abuse of power aimed at seriously impeding the establishment of an aggressive Federal gasohol initiative. I must conclude that the Administration has exhibited far more rhetoric than action on gasohol. I appreciate very much the opportunity to testify before the Subcommittee today and share with you some of my concerns. I have been following the controversy surrounding the Energy Research Advisory Board's Gasohol Study Group and its Gasohol Report since February of this year when I questioned former Under Secretary of Energy John Deutch extensively about the group. I was concerned then—as I am today—about the reasons for convening the group, the method used to select group members, the bias of those members, and how the report was used. It appears this most influential of scientific panels at the DOE was used merely as a kangaroo court, designed to lend credibility to Under Secretary Deutch's preconceived position on gasohol. After a long meeting with Secretary

Duncan last week, I am more concerned than ever. In fact, a letter that I personally gave the Secretary outlining some of my concerns remains unanswered. I am getting used to that, however. A letter I wrote last February concerning, in part, the ERAB Gasohol Study Group's report is also unanswered. I would like to submit copies of these letters for the record.

It is important to keep in mind that the funding to support Federal advisory committees and the laws concerning their operation are determined by Congress. The Congress has a right—indeed, an obligation—to ensure that the funds are spent properly and the laws obeyed. I don't think the Department of Energy, the members of ERAB, or Mobil Oil could dispute this. Advisory committees used responsibly, can serve a useful function. Their unique status, however, can invite abuse, and there has been more than one case of impropriety involved with these committees. Information supporting allegations by DOE employees and investigation by my staff indicates that the Energy Research Advisory Board, and its subgroup, the Gasohol Study Group, were misused by top officials of the DOE in an effort to intentionally impede government gasohol initiatives.

On May 22, 1980, with the full authority of the Chairman of the Energy and Water Subcommittee, I asked the staff to investigate the questionable circumstances surrounding the development of an antigasohol report by the Energy Research Advisory Board—the most influential science advisory committee at the Department of Energy. I was particularly concerned by :

The decision to launch another gasohol study only a few months after a lengthy and comprehensive review of the issue by top DOE staff which resulted in an endorsement of an increased gasohol program.

The decision to appoint two scientists with links to Mobil Oil Company to fill positions on ERAB's seven member Gasohol Study Group. As you know Mobil Oil, has been an outspoken opponent of gasohol and has patented a process for producing a rival fuel which is derived from coal-based methanol.

The indications that this apparently superfluous and biased study group had been wrongfully convened by top DOE officials to provide ammunition to shoot down congressional plans to promote gasohol as an alternative fuel.

Although the staff was armed with a letter from the Subcommittee Chairman to the Secretary of Energy, Charles Duncan, requesting full access to documents essential to pursuit of this investigation, DOE impeded the investigation by delay and refusal to provide relevant files. DOE officials are still refusing to release some of the files dealing with former Under Secretary John Deutch's role with the Gasohol Study Group.

Despite this obstruction of our investigation, the staff obtained some internal DOE files and oral statements from DOE officials that indicate a top DOE official misused the Department's most influential scientific panel to add credibility to his own preconceived position in favor of methanol and against gasohol.

(1) Before the Gasohol Study Group was convened, then Under Secretary of Energy Deutch was known to be an advocate of methanol and an opponent of an increased gasohol program. He made these views known on a number of occasions.

(2) The Study Group was assigned to virtually duplicate a report by the Alcohol Fuels Policy Review Committee which reached conclusions that did not support former Under Secretary Deutch's position.

(3) One seat on the seven member Gasohol Study Group appears to have been reserved for a representative of Mobil Oil. According to handwritten notes in the ERAB files, first to be considered was Paul Weisz, Manager of Control Research and Development Corporation, and then apparently suggested as alternate choices, J. R. White, Manager of Scoping and Technical Analysis, Mobil Research and Development Corporation, and John McCullough, a vice-president of Mobil Research and Development Corporation. I would like to submit copies of these notes and a similar memo for the record. It appears from handwritten notes that Pimentel, the Mobil consultant who chaired the group, had recommended the Mobil scientists. However, the Mobil advertisement that appeared in recent issues of the New York Times, the Washington Post, the Washington Star, claims that Deutch himself appointed Paul Weisz of Mobil—which is a clear violation of the Federal Advisory Committee Act.

(4) Professor David Pimentel, the Chairman of the Gasohol Study Group, worked directly with both Weisz and McCullough when he consulted for Mobil. But Pimentel did not make this relationship known to other members of the Gasohol Study Group or ERAB until a February ERAB meeting—four months after he accepted the Gasohol Study Group Chairmanship and three months after he drafted the Gasohol Report. He finally acknowledged his association with

Mobil and these Mobil scientists after the connection was revealed to E. Stevens Potts, an Assistant to Secretary Charles Duncan, sometime in January. Pimentel failed to report his Mobil consultancy when he filed his "Bias Statement" (conflict-of-interest report) with DOE. In fact, when the staff requested the bias statements of ERAB and study group members, DOE could only produce bias statements for 16 of 25 ERAB members, none for the Gasohol Study Group, and only 2 of 9 for the Biomass Panel. The others failed to file. Without these statements, Department of Energy Officials have no way to determine the sources of bias in the information they receive.

(5) These reserved corporate seats go beyond the Gasohol Study Group. The staff has also learned that a seat on ERAB was apparently reserved for a representative of Boeing Corporation. A document found in ERAB files indicates that when Oliver Boileau, President of Boeing Aerospace Co., was leaving the Board in 1979, he recommended he be replaced by Henry K. Hebeler, President of Boeing Engineering and Construction Co. Mr. Hebeler is now an ERAB member. This practice of setting aside what appears to be "corporate" seats on a departmental scientific advisory board raises serious questions about whether board members are selected for their personal expertise or for their corporate connections.

(6) Former Under Secretary Deutch did not wait for a final report on the Gasohol Study Group's findings to be approved by ERAB before firing off a memo to DOE Secretary Duncan with negative recommendations for the gasohol program. The Federal Advisory Committee Act prohibits study groups from making recommendation directly to department officials before those recommendations receive full approval of the parent advisory board. Despite this prohibition, the Gasohol Study Group members briefed Deutch who used their preliminary and unsanctioned findings to support his anti-gasohol views.

(7) This apparent campaign to derail the gasohol program was halted by President Carter's decision to endorse gasohol development. On January 11, 1980, shortly after the Soviet grain embargo and before the January Iowa caucuses, President Carter announced a massive gasohol program. Were it not for the President's actions, the Under Secretary, with the support of ERAB might have succeeded gutting the gasohol program.

(8) The negative findings of the Gasohol Study Group were strongly disputed by E. Stevens Potts, Acting Director of the Office of Alcohol Fuels, in a memorandum to Secretary Duncan on May 1, 1980. He attacked both the Study Group's objectivity and competence and recommended to Duncan that he disavow the Study Group's findings. I would like to submit a copy of this memo for the record. Secretary Duncan, however, all but ignored Potts' recommendations and instead lavished praise on the ERAB in a letter to the ERAB Chairman on May 7, 1980. I would like to submit a copy of this letter for the record. Also, Deputy Secretary of Energy, John Sawhill went out of his way to apologize to the Board for the Potts memo at a May ERAB meeting.

(9) Finally, the new ERAB Biomass Panel has many of the same problems that the Gasohol Study Group did, including the same members with Mobil ties. Members of Congress, officials of DOE's Consumer and Alcohol Fuels Offices and concerned citizens objected to the unbalanced make-up of the Gasohol Study Group. But despite this outrage over what was perceived as a biased panel, five of the seven Gasohol Study Group members have been reappointed to a new nine member ERAB Biomass Subgroup. Pimentel will again be Chairman and Paul Weisz of Mobil has been named as a panel member. The Biomass panel will study alternate fuels, including, of course, gasohol: I've already been told by top DOE officials that the Biomass Subgroup will not change the findings and conclusions on gasohol because it would be an embarrassing admission that they were wrong the first time.

The apparent lack of concern for the objections of DOE staff, Members of Congress, and concerned citizens pervasive throughout this entire debate is inexcusable. From the unanswered letters to the formation of a Biomass panel with virtually the same membership as the Gasohol Study Group, both the DOE and the ERAB seem unconcerned with what some of us see as grave problems. In light of the current series in the Washington Post on government contracting abuses, I think it is evident that we need to exercise extreme care when the United States Government solicits advice from private corporations or their employees, universities, and consulting firms. I reject the argument that this investigation and this hearing are attempts to capitalize on popular sentiment by attacking a large oil company; my colleagues and I are rightfully concerned about the highly regarded advice received by the Department of Energy and how that advice is being used. I hope we all have the same ultimate objective in mind: a sound, constructive energy policy that will lead us away from our suicidal

dependence upon foreign oil sources. Without complete utilization of all practical energy sources, this will be impossible. Without fair, objective analysis—unobstructed by corporate interest or bureaucrats' personal interests—it will be impossible to determine what all these available sources of energy are.

CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
Washington, D.C., February 15, 1980.

Hon. CHARLES W. DUNCAN, Jr.,
Department of Energy,
Washington, D.C.

DEAR SECRETARY DUNCAN: I am very concerned about the fate of the President's announced alcohol fuel program. Since the President made his January announcement, I have seen little to convince me that the program will actually be carried out. In fact, I worry we are regressing in efforts to speed development and commercialization of alcohol fuel. I cite as a case in point the conferees' position on the tax credits and exemption for alcohol fuel. I realize that the Administration and the Department does not have control over the Congress, but I find it hard to believe that any intensive lobbying for the President's stated position was undertaken.

I am cognizant of your support of the gasohol and alcohol fuel concept, and I realize that the Department has taken great strides forward since you have assumed the position of Secretary. However, I am afraid that all in the Administration and in the Department that you head do not share your feelings. In order to satisfy myself, I plan to pursue questioning in this month's budget hearings to determine how well the President's directives are being carried out.

Before the Appropriations Subcommittee on Energy and Water Resources holds hearings later this month, I would like your office to respond to some general questions and requests for information that may help me to understand the current alcohol fuel situation in the Department of Energy.

(1) In light of the current organizational disarray—I am referring specifically to the DOE's fledling Alcohol Fuels Office and the admittedly understaffed USDA Energy Office—how does the Department intend to meet the President's goal?

(2) I understand that in the Spring of 1979, the President directed that 10 percent of Federal vehicles should be using gasohol within a certain time period. What is the current status of the progress toward that goal?

(3) Please explain the relationship and extent of coordination between the DOE and USDA in the alcohol fuel program.

(4) Please outline for me the status of the request for a grant for research and development funding made by the Scottsbluff Payroll Development Foundation. I would like to be provided with a time line showing the progress to date over the time frame involved and estimated time period expected before a decision on the application is final.

(5) Please supply any information relevant to contracts let by the DOE for methanol or ethanol studies by private firms during the last five years. Of special interest to me are studies conducted by the Mobile Corporation. Please supply copies of the reports or draft reports prepared under contract EF-77-C-01-2623.

(6) Please supply my office a copy of the paper entitled "Gasohol Study," prepared by the Energy Research Advisory Board's Gasohol Study Group.

Thank you very much for your attention to these requests, and I am looking forward to discussing these matters with you and your staff later this month.

With best wishes, I am

Sincerely,

VIRGINIA SMITH,
Member of Congress.

CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
Washington, D.C., June 16, 1980.

Hon. CHARLES W. DUNCAN,
Secretary, Department of Energy.

DEAR MR. SECRETARY: As a result of our meeting Monday, June 16, I would appreciate it if you would submit a letter to me addressing the following concerns.

(1) Reaffirmation of the Administration's national commitment to the rapid development and commercialization of ethanol for fuel.

(2) A progress report on steps taken to achieve the President's goals for ethanol, and indication of intentions and goals for ethanol in the next decade.

(3) Acknowledgment that selection, membership, and operation of the Gasohol Study Group makes its report at least suspect, and at worst deliberately biased against ethanol.

(4) Agreement to remove the Office of Alcohol Fuels from its present position in the Department as quickly as possible in anticipation of S. 932.

(5) Detailed steps to be taken to insure that the Energy Research Advisory Board and its study groups operate according to both the spirit and letter of the Federal Advisory Committee Act.

(6) Review by the Inspector General of the selection process and operation of DOE advisory boards and their subgroups, including the recently established biomass Study Group.

In order to best serve our mutual interests, this letter should reach my office by the close of business today. Thank you very much for your cooperation.

Sincerely,

VIRGINIA SMITH,
Member of Congress.

Bob Rawson

gasohol advocate (Mike Shaler RAW 4/6

Meeting 10-11 Dec Gasohol
Dick Hinman 203 445 5611, 1541
Tom Atelson DOE 376 9041
Barbra + Tom

Pimentel Dave 607 256 2212 2722668
JR White or ~~from McCulloch~~ (Pimentel) → get ~~John White~~ from McCulloch
Paul Weiz Mobil 609 737 3000 x2301
add not available Clair

(Hinman) (Biochemical Engineer)
Charlie Cooney (MIT) 617 253 3108
add ZIP 02139
send one to Kirschbaum

* Get copies of Dam Motor Fuel Alcohol Technical + Economic Assessment Study from Blum

(8)

* Conference Room

Hinman 11/14

1) Is utilization of Alcohol as a motor fuel (with minimal subsidies) practical ~~utilizat~~ utilizing a best case for gasohol scenario. If so, what is research + Development required ~~to~~ to achieve this best case.

2) What is impact of widespread gasohol utilization on farm industry oil industry etc.

Personal Notes
Not for Distribution, [illegible]

INFORMATION MEMORANDUM FROM DEPARTMENT OF ENERGY

To Deputy Secretary.
Through: Under Secretary.
From: Acting Director, Office of Energy Research.
Subject: Energy Research Advisory Board study group on gasohol.

PURPOSE

To provide the Deputy Secretary with information regarding the status of the Energy Research Advisory Board review of gasohol.

BACKGROUND

In response to John Deutch's commitment to the Deputy Secretary to review the gasohol issue, Dr. Solomon J. Buchsbaum, Chairman of the ERAB, is convening a special Study Group of the Board. This Study Group will be chaired by Dr. David Pimentel, a member of the Board from Cornell University.

DISCUSSION

The Study Group will meet here in Washington on December 10–11 (see attached tentative list of members). Dr. Pimental understands the necessity for rapid response on this matter and plans to deliver a final report the week of December 24.

Attachment.

ENERGY RESEARCH ADVISORY BOARD STUDY GROUP ON GASOHOL

Dr. David Pimentel, Chairman,[1] Cornell University.
Dr. Charles Coonie, Massachusetts Institute to Technology.
Richard L. Hinman,[1] Pfizer, Inc.
William Scheller, University of Nebraska.
Thomas Stelson,[1] George Institute of Technology.
Paul Weisz, Mobil Oil; or John McCullah, Mobil Oil.
DOE staff support: Sandy Harris, Conservation and Solar; Robert Rabson, Energy Research.

MEMORANDUM FOR THE SECRETARY, DEPARTMENT OF ENERGY

From: E. Stevens Potts, Acting Director, Office of Alcohol Fuels, Conservation and Solar Energy.
Subject: Energy Research Advisory Board: Report on gasohol.

As you are aware, the ERAB has been gestating for some time now over a report on Gasohol.

The effort, which was originally touted to be a quick look by high-level scientists at the gasohol issue, has dragged on for several months, amid considerable controversy.

The controversy focuses upon the objectivity of the panel and the effort, and casts doubt on both the objective, independent judgment and scientific character of the ERAB itself, and upon the utility and viability of the ERAB as an advisory panel providing scientific judgment to top-level government policy makers.

The issues against this particular effort include:

1. The selection of the Study Group Chairman, who was a paid consultant to the major industry antagonist (Mobil Oil) against gasohol, and who had published in scientific journals a viewpoint which is prejudiced against fuel alcohol.

2. The inclusion of Dr. Tom Stelson as a panel member during the time he was under the confirmation process to be the Assistant Secretary for Conservation and Solar Energy and thus an allusion to the liability of the potential of his being materially influenced by senior level policy makers in the Department.

3. The inclusion of the major industry opponent to gasohol (Dr. Paul Wiesz, Director, Mobil Research and Development Corporation) as a group member during the period of time when Mobil was actively fighting gasohol while simultaneously promoting the Mobil process to convert coal to methanol, along with a representative of a major competitor for fermentation feedstock, Dr. Richard Hinman, V.P., Pfizer, Inc. With Stelson absent and preoccupied much of the time

[1] ERAB members.

with his confirmation process, the majority of the study group participants thus was constituted of antagonists, not objective scientists.

4. The lack of inclusion of any balanced representation of the alcohol fuel industry. Only one representative, Dr. William Schellar, could claim any substantial exposure to the industry.

5. The lack of public announcement of the Study Group Meetings, the complete lack of public participation or representation in the process, and the violation of DOE regulations in the manner and method in which the Study Group carried out its business, including the failure to provide a public transcript for the majority of the meeting time, or the opportunity for the public to attend the meetings.

6. The almost complete lack of scientific data or statistical facts, other than previously published works by the Study Group participants.

7. The challenge to ethanol on the net energy return basis, without consideration of the 2 for 1 BTU loss in producing methanol from coal.

8. The obvious inaccuracies and lack of statistical basis in the projections developed by the group. (Projecting 200–300 million gallons per year maximum by late 1981, when one major producer (ADM) alone has announced a capacity of 250 million gallons by the end of 1981.)

9. The lack of financial expertise by the members of the panel, yet the heavy dependence upon their own financial projections as a basis for their judgments.

10. The allusion to "evidence" of the use of ethylene-derived ethanol to replace fermentation-based ethanol in gasohol, without scientific or sound evidentiary basis.

11. The complete lack of regard to proper cost estimating procedures in the data presented in the report, including the failure to include construction costs in estimates of costs to produce methanol from coal.

12. The use of energy consumption figures which fail to represent any documentary evidence for ethanol fermentation and distillation, and far exceed tested data derived from actual plants.

Those twelve points are only a few of the controversies surrounding this particular study. It now appears publicly to be just what we assumed it to be at the outset, an attempt to "railroad" the gasohol issue by enveloping a biased and poorly substantiated report in the cloak of supposed scientific judgment of the Energy Research Advisory Board.

The truly unfortunate aspect of this effort is that the manner in which it was conducted will cast doubt upon the integrity, capability and scientific independence of the Energy Research Advisory Board, and simultaneously create repercussions for the Department of the sort shown at Tab A.

I believe your public comments on the report should be as follows:

The Energy Research Advisory Board has issued a report of a Study Group on Gasohol.

Considerable doubt has arisen as to the method in which the Group was convened, the selection process for the members of the group, and the objectivity and scientific basis of their report.

Further doubt has been cast upon the method by which the Energy Research Advisory Board carries out its charter.

We will consider the report as just that, a report by a group of hastily convened individuals, some of whom may be substantially biased in their outlook by the fact of their personal situations.

The report will not be considered as a statement of this Department's policy or outlook on the gasohol issue.

We will review the Energy Research Advisory Board activities and method of operation and determine whether or not action should be taken to see that its future efforts conform more closely with existing laws, DOE regulations, and the need for objective judgment by the Department of Energy.

You should then indicate that you have not reviewed the report itself and will make no comment as to its content.

SECRETARY OF ENERGY,
Washington, D.C., May 7, 1980.

Dr. SOLOMON J. BUCHSBAUM,
Chairman, Energy Research Advisory Board, Bell Laboratories, Holmdel, N.J.

DEAR DR. BUCHSBAUM: I have received the Report of the Energy Research Advisory Board (ERAB) on Gasohol. I know a great deal of effort went into this Report which was conducted on very short notice. I want to express to

the Board my personal appreciation as well as that of the Department of Energy. You may be assured that the results will be carefully considered in formulating the Department's gasohol program.

I have asked the Assistant Secretary for Conservation and Solar Energy to direct the Office of Alcohol Fuels to review and respond in detail to the Report's recommendations and report back to me by the end of the month. You may wish to have the Office of Alcohol Fuels report on the review at the next regular ERAB meeting. As you point out, the scientific and technical developments related to the gasohol issue are in a continuous state of flux and deserve further research. I would welcome the continuing advice and counsel of ERAB on these matters through the activities of the Board's Biomass Panel.

I want to assure you that I, and the principal officers of the Department, have the highest regard for the conduct of the Gasohol Study Group and have full confidence in the technical expertise, objectivity and integrity of the members.

The contributions of ERAB have been and will continue to be of great value to the Department. I appreciate and support the Board's efforts to provide objective and independent advice to the Office of the Secretary, the Director of Energy Research and the Assistant Secretaries. I will continue to depend on ERAB for advice on scientific and technical issues that I know will affect profoundly our ability to solve our Nation's energy problems.

Sincerely,

CHARLES W. DUNCAN, Jr.

Senator McGOVERN. Thank you very much for your statement, Representative Smith. We appreciate your being with us.

Representative BEDELL. Representative Smith, if I have to be here and can't be on the floor for your important amendment, I'm sure you will understand.

Representative SMITH. Thank you very much.

Senator McGOVERN. In view of the fact that some people are unable to get into the room, if those who are standing could kind of move over to this side and some are welcome to take these chairs at the witness dais if they wish, at least until other members of the committee come. So if you wish to take these chairs over in this area, please feel free to do that.

In view of the comments that Congresswoman Smith just made with reference to the composition of the biomass panel, I would like to ask that a letter that Congressman Bedell and I sent to the Secretary of Energy on May 12, in which we asked him to remove five of the nine members of the biomass panel who had also served on the Gasohol StudyGroup.

[The letters referred to follow:]

U.S. SENATE,
Washington, D.C., May 12, 1980.

Hon. CHARLES DUNCAN,
Secretary, Department of Energy,
Washington, D.C.

DEAR MR. SECRETARY: We wish to convey our alarm and dismay over the continuing drift toward rejection of on-farm and rural community based facilities in the Department of Energy's efforts to develop policy recommendations concerning the utilization of alcohol as an alternative and renewable source of energy.

Specifically, we refer to the newly formed Biomass Panel of the Energy Research Advisory Board and a recently released study which portrayed a biased and distorted picture of the true value and potential of on-farm, small scale alcohol production. That report, produced by the Gasohol Study Group subpanel of the Energy Research Advisory Board, and endorsed by the Board, called for expanded production of alcohol from coal and wood. This course requires high cost, large scale production facilities by a relatively few plants owned by big corporations.

Small scale production of alcohol from farm produced feedstocks was relegated to an inconsequential level in the report, despite the fact that this is the only alternative liquid fuel option immediately available to reduce dependence on foreign oil. Thousands of farmers in hundreds of rural communities stand ready to produce billions of gallons of alcohol fuel if the Federal Government will only commit itself to a firm, consistent and adequate policy of providing needed financial assistance and technical support.

The newly formed Biomoss Panel, as part of its work, has the opportunity and we think the responsibility to correct the serious errors of the Gasohol Study Group by developing a set of recommendations which establish balanced and equitable policy regarding alcohol fuels production, one which gives proper emphasis to onfarm and small scale facilities.

However, we find that five of the nine members of the Biomass Panel are former members of the Gasohol Study Group and that three of these five are members of the Energy Research Advisory Board. The composition of the Biomoss Panel makes it clear that the deck is going to remain heavily stacked against small scale alcohol production and its promise of energy self-sufficiency for rural America.

In view of these circumstances, we call on you to immediately replace the five former Gasohol Study Group members who are now on the Biomass Panel with new appointees who will provide even handed representation of the public interest and the nation's full capacity to produce alcohol fuels.

The need to do so is made all the more urgent by the fact that the Chairman of the Biomass Panel, Professor David Pimentel of Cornwell University, was also Chairman of the Gasohol Study Group, a paid consultant of Mobil Oil, and has publically opposed fuel alcohol. Furthermore, Dr. Paul Wiesz, Director of Mobil's Research and Development Corporation was a member of the Gasohol Study Group and is now a member of the Biomass Panel. The other members of the Biomass Panel who should be replaced because they were members of the Gasohol Study Group are Richard L. Hinman, Vice President, Pfizer Corporation; Charles Cooney, Department of Biochemical Engineering, Massachusetts Institute of Technology; and Professor Jack Spurlock of the George Institute of Technology.

Only with these changes will the Biomass Panel have a fair chance of assessing the facts and correcting earlier recommendations which we think lead to large scale, big corporation control of alcohol fuels on a pattern resembling the nation's centralized oil industry.

The country's farmers and rural communities must be given the opportunity to become full participants in an all out effort to develop and utilize alternative energy resources.

Sincerely,

GEORGE MCGOVERN,
U.S. Senator.
BERKLEY BEDELL,
Member of Congress.

THE SECRETARY OF ENERGY,
Washington, D.C., June 16, 1980.

Hon. GEORGE MCGOVERN,
U.S. Senate,
Washington, D.C.

DEAR SENATOR MCGOVERN: This is in response to your letter regarding the Gasohol Study Group and the Biomass Panel of the Energy Research Advisory Board. The Board is an independent, scientifically-oriented group that advises my Office. It is one of many sources of advice used by the Department and its reports do not represent official Department of Energy policy. The members of the panels and study groups of the Energy Research Advisory Board are selected to provide balanced expertise on relevant technical issues. The recommendations forwarded by the panels are reviewed by the twenty-six member Energy Research Advisory Board. The broad range of experience represented on the Board further insures that the recommendations of a particular panel are reviewed from diverse perspectives.

The Report on Gasohol prepared by the Gasohol Study Group of the Energy Research Advisory Board is a broad overview of gasohol options available now and after 1985. The report does *not* advocate one form of alcohol production over

another. Rather, it reviews the advantages and disadvantages associated with each form of alcohol production.

I assure you that the Department is not drifting toward a policy of rejecting on-farm and rural community-based alcohol production facilities. The Gasohol Report specifically recommends further study of small-scale on-farm alcohol production and utilization. The report did not go into a great deal of detail on this issue because the Study Group lacked sufficient technical data on small scale production to incorporate a detailed discussion of this issue. The issue of small scale self-sufficiency for rural America currently is being studied by the Biomass Panel of the Board. The Biomass Panel is seeking scientific and technical information on small scale alcohol fuel production from all sources.

Your letter questions the composition of the Biomass Panel of the Energy Research Advisory Board. This Panel is a technically-oriented advisory group that provides one source of advice to the Department on Biomass issues. Each member of the Biomass Panel was selected to provide a balance of scientific disciplines crucial to its work. The Panel's meetings are open to the public and the Panel has sought and will consider technical and scientific information from all sources. Finally, the recommendations of the Panel will be reviewed by the Energy Research Advisory Board. For these reasons and because the checks and balances of the advisory process assure that the Board's recommendations will be as objective as possible, I do not believe it is necessary to replace any of the members of the Biomass Panel.

In particular, I believe your concerns about Dr. Pimentel may be based on incomplete information. Dr. Pimentel is a highly respected agricultural scientist who has devoted his career to helping the farmer improve agricultural practices. He has stated that he has never published any views opposed to alcohol fuels, nor does his relationship with Mobil Oil seem suspect. In 1979 Mobil Oil undertook a review of an agricultural system prepared by Dr. Barry Commoner's organization. Mobil Oil awarded Dr. Commoner's organization a grant of $7,500 to submit and review relevant data pertaining to this system. In addition, because Mobil Oil had no in-house expertise in the agricultural field, Dr. Pimentel was asked to assist with this review. Dr. Pimentel stated that he agreed to assist Mobil Oil only in the capacity of an independent consultant. He served in that capacity for 4½ days in the time period July to November, 1989. Based on this information, I would not consider Dr. Pimentel's activity a conflict of interest.

You know that I am personally committed to alcohol fuels. Since I took office as Secretary of Energy, the Department has moved aggressively in encouraging alcohol production from all sources. This advisory panel is composed of members with diverse views on alcohol fuels. I believe the diversity of the members' views will combine with the operation of the advisory process to give the Department and the public another valuable perspective on alcohol fuels.

Sincerely,

CHARLES W. DUNCAN, Jr.

Senator MCGOVERN. I would also like to ask that the lead story on the front page of today's Washington Post which details the tendency on the part of the Department of Energy to contract out most of its studies and analytical responsibilities to private industry, virtually a major part of the DOE budget, that that story be made a part of the record.

[The article referred to follows:]

[From the Washington Post, Wednesday, June 25, 1980]

CONTRACTORS, CONSULTANTS GET 87 PERCENT OF DOE BUDGET

(By Phil McCombs)

The federal Department of Energy is spending about 87 percent of its $11 billion budget on outside consultants and contractors who are performing most of its basic work, Sen. David Pryor (D-Ark.) said yesterday.

Pryor and Rep. Herbert E. Harris II (D-Va.) heard testimony in hearings yesterday that the Energy Department has 4,000 contracts with more than 200,000 contract workers - nearly 10 times the agency's 21,000-member staff.

Pryor charged that this massive use of contractors has led to a "basic change in the way the government does its work. . . . [The department's] reliance on

contractors is so extreme that . . . it is hard to understand what, if anything, is left for federal employees to do."

Pryor and Harris, cochairmen of yesterday's hearings, said their congressional staff investigations showed that:

Contractors—not government officials—often prepare speeches and documents given by the officials in congressional testimony.

The Energy Department's filing system is in such disarray that the agency cannot produce the results of millions of dollars of contract work, and sometimes not even the contract document itself.

Contractors are often paid to produce their own "task orders," which describe what they are to do on a particular contract job.

The department is paying millions of dollars to big consulting firms that also work for oil and utility companies despite conflict-of-interest rules that the agency put into effect last year.

Citing what they described as a lack of accountability by contractors, Pryor and Harris said they will introduce in Congress later this week a consultant reform act seeking to increase disclosure by government consultants and to curb their role generally.

In yesterday's joint hearing of the Senate subcommittee on civil service and general services and the House subcommittee on human resources, the Energy Department's chief financial officer, John A. Hewitt Jr., testified that the agency has taken strong new steps to curb what he said were "past, improper practices" regarding contractors.

"I am committed to institutionalizing the department's policy that contractors will not perform functions that government employees should perform," Hewitt said.

He said that new Energy Department rules calling for closer scrutiny of contract proposals resulted in 39 of 55 recent proposals being found not satisfactory.

"Some (proposals) did not clearly establish the need for a consulting service contract; (others) appeared to call for the contractor to perform functions" that Energy Department officials should perform, Hewitt said.

He did not say whether the 39 proposals were ultimately rewritten and approved, but he added: "A cynic might assert that (DOE officials and contractors) are merely choosing their words more carefully."

Harris asked Hewitt why TRW Energy Systems Planning Division, a consultant, had been allowed to write its own task order, or contract, on April 24 for an assessment of coal slurry pipelines.

Hewitt said he didn't know that that had happened. "I'm sure you can still find some examples" of practices that should not take place under the new department rules, Hewitt told Harris.

"I think they (contractors generally) are still doing just like they always did," Harris said.

Robert H. Shatz, TRW's vice president for the energy systems planning division, said after the hearing yesterday that he had not seen the testimony and could not comment specifically. But he said: "I don't think contractors should run DOE and I know they don't. DOE runs the contractors."

Pryor said that Planning Research Corp., a consultant, is hired to answer letters sent to Energy Department officials by members of Congress. He mentioned a draft letter the consultant prepared on Aug. 22, 1979, to be sent to Rep. Richard Ottinger (D-N.Y.).

Hewitt said he didn't know about such letters and said he has not signed any such letters prepared by outsiders.

A spokesman for Planning Research Corp. said after the hearing that the firm provides the department with "technical analysis" needed to answer letters. "We don't respond to political or policymaking-type questions," the spokesman said.

Pryor said the company and Booz-Allen & Hamilton Inc., another big consulting firm, do millions of dollars of contracting work for the Energy Department and, at the same time, Planning Research Corp. consults for oil companies and Booz-Allen for utility companies. The Energy Department plays a role in regulating both industries.

"This reliance persists despite the conflict-of-interest rules introduced by the department last year," Pryor said.

The company spokesman said: "We don't have any conflict of interest between DOE and the oil company (work) because the work is totally unrelated." Planning Research Corp. does solar analysis for DOE and mostly engineering and architectural work for the oil companies, the spokesman said.

Booz-Allen senior vice-president Eric Zausner said there is no conflict in working simultaneously on Energy Department solar programs and on load forecasting and other utility company projects. "We've never represented the utilities before DOE in any way," he said.

Pryor disclosed yesterday a Booz-Allen internal memorandum obtained by his staff as part of the contractor's "work product" paid for by DOE. The memo, from Booz-Allen employe to another, told of attending a "solar jubilee" conference in Phoenix and stated that:

"The meeting was inspiring in terms of giving insight into possible business areas for (Booz-Allen)."

"This was paid for by the government," Pryor said.

Zausner said the Booz-Allen man who wrote the memo attended the meeting on his own vacation time and not at government expense. He said the memo "got in there by mistake" when the firm had to rush to provide "seven cartons of work product" to DOE in two days in preparation for yesterday's hearing.

Senator McGOVERN. Now in the interest of conserving time, I'm going to call on four of our witnesses to testify as a panel. They are Mr. Barry Commoner, Mr. William Scheller, Mr. Alfred Campbell, and Mr. Al Mavis. Gentlemen, if you four would come forward now and take your seats at the witness table, following your statements I'm going to ask that you return to the audience so we can hear from Assistant Secretary Thomas Stelson and Mr. E. Stevens Potts. Then at the end of the testimony of Mr. Stelson and Mr. Potts we will ask the four of you to come back so we can question all of the witnesses together.

I think at this point, Mr. Commoner, if you're ready to go, we will proceed with your testimony and then we'll turn to Mr. Scheller and Mr. Campbell and Mr. Mavis in that order. Mr. Commoner, we are glad to welcome you before this committee.

STATEMENT OF BARRY COMMONER, DIRECTOR, CENTER FOR THE BIOLOGY OF NATURAL SYSTEMS, WASHINGTON UNIVERSITY, ST. LOUIS, MO.

Mr. COMMONER. Thank you, Senator McGovern. I will be as brief as I can.

I think the issue that you have raised here is of very considerable importance not only for the energy policy of the country but also for its agricultural policy, and I'd like to very briefly make some remarks about the ERAB report and the relationship of my own research group, the Center for the Biology of Natural Systems, to it.

First: I'd like to point out that we have been engaged at CBNS in an analysis of the very problem which is under consideration here: That is, what is the feasibility of producing ethanol from agricultural crops? That work is being supported and has been supported by two grants, one from the Ford Foundation and another a grant of about $150,000 from the Department of Energy which I expect to continue next year.

The main point that I want to make is that the ERAB report contains a series of important scientific errors which result in the very pessimistic conclusion regarding the advantages of producing ethanol from crops in comparison with methanol from coal.

Apart from that, I want to point out a procedural problem. In scientific discourse, as I'm sure you know, it's important for individual investigators to exchange information and views, and in the case of the ERAB report we at CBNS and the Mobil staff had a particular

opportunity to exchange views in advance, well in advance of the preparation of the ERAB report. I'd like to tell you how that came about.

It came about as a result of an invitation that I accepted last fall to participate in a dinner at the Woodrow Wilson Foundation here in Washington. At that dinner Mr. Raleigh Warner, the president of Mobil, was present and was asked by the chairman of the dinner to make remarks about energy policy, and he made a series of very pessimistic remarks about the future of solar energy and in particular the production of ethanol from crops.

In the course of the discussion I disagreed with him rather vehemently and presented evidence in contradiction of what he said. The outcome of the evening's discussion was that Mr. Warner expressed a concern about the disagreement between his views, the views of his staff, and my own.

Shortly thereafter, I received a letter from Mr. McCoullough of the research staff of Mobil asking whether he could bring his staff to our center to discuss the problem. Naturally, I agreed and a meeting was held.

Since the meeting involved taking time away from our work, Mobil offered a grant of $7,500 to the university in respect of the work that we would do. That money was accepted. It went to the university and was applied as a matching grant to another grant that we had from a private foundation to make public useful information about environmental pollutants, particularly those from the petrochemical industry. I felt that that was a very appropriate way to use Mobil's money under the circumstances.

At that meeting we had a very detailed exchange of information in which we severely criticized the assumptions and the analyses which largely provided the basis of the ERAB report.

One of the most distressing features of the ERAB report was that it paid scant attention to the criticisms that we made. It was their obligation I think to mention our criticisms and to rebut them thoroughly. They failed to do that and I regard that as one of the weakest aspects of the report.

I just want to take a little time now to explain the scientific reasons for the faults in the ERAB report. The ERAB report makes a big point over the claim that any extensive production of ethanol from crops would interfere with food production and in fact that claim has been repeated now a number of times by other commentators and that I think is one of the most fundamental issues that we have to straighten out.

This first chart provides the basic information which shows why we at CBNS have come to the conclusion that even with present technology midwestern agriculture could produce enough ethanol to replace one-third of the gasoline demand in the United States, whereas as you already mentioned the ERAB report asserts that no more than 800 million gallons, which is a very small fraction of the gasoline consumption, could be made.

The reason for the disparity is that the ERAB report fails to consider a basic scientific fact regarding fuel and food. In this chart, the first column here is the composition of the present biomass produced by midwestern agriculture which is the bulk of U.S. agricultural out-

put. The blue column is the total amount of carbonatious material, the carbon. The green is nitrogen. The ratio is 21 to 1. That reflects a carefully worked out balance between carbohydrate and protein in nutrition.

What it reflects is that at the present time Midwestern agriculture is designed to produce livestock. That is the main purpose and it does it very well by an appropriate balance between carbon and nitrogen. Now that explains why, if you do not change the crop pattern in agriculture, there is very little opportunity to produce much alcohol without interfering with food production. In other words, if you take the fact that the fuel contains carbon but no nitrogen, now if you want to make fuel out of the present agricultural system you will cut down on the required amount of carbon and you will necessarily cut down on the production of food.

Once you understand that, the solution becomes obvious. You change the crop system in order to put extra carbon into the output so that that carbon can be drawn off in the form of ethanol, leaving the requisite amount of carbon and nitrogen to maintain food production.

In the second column, I have illustrated a crop system which we developed under our grant from Ford and DOE in which soybeans are replaced by sugar beets. Soybeans are rich in nitrogen. Sugar beets are rich in carbon. And the result is an extra 90 million tons of carbon a year produced and when that is converted to ethanol it amounts to about one-third of the gasoline demand in the United States. What's left then is exactly what you need to raise the requisite amount of livestock.

So the first fundamental fault in the ERAB analysis is that they failed to consider the inherent flexibility of the agricultural system.

One might argue, well, we can't do that; but that's exactly what was done after World War II when in a matter of 10 years a large part of the corn acreage was replaced by soybeans. In this case, the scheme was to put more nitrogen in. Now what we have to do is put more carbon in. So this fundamental error I think lies behind a claim that they can't produce much ethanol without cutting food production.

Now, a second basic point is revealed in this second chart. This is a series of estimates made by ERAB and by CBNS. CBNS is the first column, ERAB the last. And in between two other estimates made by OTA in an earlier DOE study. This is an estimate of the maximum production in 1980, 1985, 1990, and 2000. You notice that ERAB always lags behind every other estimate and the question is, why? The answer is that in the other estimates, and particularly ours, shifts in the crop system were introduced. So, for example, this column "b" is a shift in the balance between corn and soybeans, a very simple thing to do.

When that is taken into account as a way of emphasizing carbon for alcohol production, you get more output. You notice that ERAB failed to consider that alternative.

The other alternative, "C," is the introduction of sugar crops. They failed to consider that as well.

Finally, even in the question of converting alcohol from cellulose, they failed to consider an extremely important point; and that is, that two kinds of alcohol can be produced from cellulose. The cellulose products proper breaks down to six carbon sugars which are ferment-

able to produce ethanol. What they forgot is that the hemicellulose, another type of cellulose, breaks down to five carbon sugars which, although they will not ferment to produce alcohol, can be converted by bacterial action to another alcohol, butane diol, which is also so an excellent motor fuel.

The result is that in the year 2000 when the cellulose technology comes in, their figure is only 30 billion gallons a year, whereas ours goes to 150 billion gallons a year. In other words, I make the claim that ERAB's pessimism is the result of a failure to understand the full potential of fermentation schemes.

Another point that needs to be made is that their estimate of the energy balance is incorrect, again, because of their failure to consider key points; and I will make only one point here.

One of the important points to consider is the energy saved by failing to refine gasoline which is replaced by alcohol, and it's well known that gasoline production requires the expenditure of energy. This is known as the refinery loss. Their estimate of refinery loss does not appear in the game, whereas that light green column is the refinery loss.

Another point that they omitted completely is the well known fact that the mechanical energy obtainable from gasohol is more than the heat energy that you would get by simply burning alcohol. That is, there are mechanical advantages to ethanol. They simply ignored that feature and that explains why the net energy balance that we get at CBNS agrees with the one at OTA and the ERAB energy balance agrees with the very pessimistic figures published in 1978 by a very early and inadequate analysis. Again, I think it is simply scientifically weak.

The last point I want to make has to do with the ethanol/methanol question. They talk a good deal about the cost advantages of producing methanol from coal as compared to ethanol, but we have to remember we are talking about the future and I have plotted here estimates of the alternative prices of ethanol from corn and methanol from coal, and you notice that whereas the ethanol price remains constant, the cost of producing methanol has been rising exponentially. That is explained by the fact that methanol production from coal involves very serious environmental effects and as they discovered—just as in the case of nuclear power—it becomes a more costly process.

One of the most distressing aspects of the ERAB report was that they totally ignored in their draft report—and then in their final report made some changes as a result of our criticism—they ignored the serious environmental effects of producing methanol from coal, whereas they went into great detail about the environmental effect of producing ethanol from corn. In other words, there was a distinct bias in the environmental treatment of the two alternative systems.

So my conclusion is and has been for a long time that the ERAB report failed to understand the problem. The problem is how do we use the agricultural resources available to us, the land, the capital the labor—the resources to maximize the production of both food and alcohol?

If you ask that question, the answer is that we can immediately, with present technology, go to a production of between one-third and one-half of the gasoline demand by farm alcohol and when cellulose

technology is introduced, and it can be in a few years, we can replace all the gasoline used in the United States by ethanol from crops with an enormous implication for the whole economy of the agricultural sector and an enormous implication for its ability to compete with the oil companies.

I find that the ERAB report totally failed in its mission of providing adequate advice to the Department of Energy and I hope that the criticism that is developing here will help straighten out Government policy in that respect.

[The prepared statement of Mr. Commoner follows:]

PREPARED STATEMENT OF BARRY COMMONER[1]

Issues Affecting the Future of Alcohol Fuels Production in America

[1] Prepared in collaboration with Richard Carlson, David Freedman, Neil Jacobstein, Jim Kendell, Robert Scott, and Holly Winger.

I. INTRODUCTION

The focus of this hearing--the findings of the Gasohol Study Group of DOE's Energy Research Advisory Board (ERAB)—has important implications for the development of a national policy on nonpetroleum sources of liquid fuels. The ERAB report concluded that ethanol should play a very minor role in meeting the nation's future liquid fuel needs, and that another liquid fuel, methanol from coal, should be the major alternative. This finding was similar to the findings of other recently released reports on ethanol production, particularly those by DOE's Alcohol Fuels Review, the Office of Technology Assessment and the Worldwatch Institute. However, the ERAB report stands out as one of the most pessimistic. The highest ethanol production level from agricultural crops discussed by ERAB, 800 million gallons per year after 1985, was less than one-tenth as high as the estimates cited in DOE's Report of the Alcohol Fuels Policy Review.

In contrast to the pessimistic conclusions of the ERAB report, as well as the other recent studies, analyses by CBNS show that ethanol and other alcohols could be produced from biomass in sufficient quantities to replace all gasoline usage by the year 2000, with favorable environmental and social impacts. These disagreements cannot be explained simply on the basis of differences in data, or on a lack of familiarity with the CBNS analyses. Members of ERAB's Gasohol Study Group have on two occasions discussed the potential for ethanol production with CBNS staff. The first instance occurred at a discussion in St. Louis, held at the request of Mobil, on Oct. 4, 1979, which was attended by Dr. Paul B. Weisz, Manager, Central Research Division, Mobil Research and Development Corp., and three other Mobil executives (J. P. McCullough, S. L. Meisel, and C. H. Reing). Also present was Dr. David Pimentel, acting as a consultant to the Mobil group. In the course of this discussion, both Dr. Pimental and Dr. Weisz, who were later to serve as chairman and member, respectively, of the Gasohol Study Group, were fully apprised of the CBNS analyses on ethanol production from biomass. Then, on Feb. 8, 1980, Richard Carlson of the CBNS staff presented to ERAB a detailed critique of the study group's draft report (see Appendix I). Although the final version of the study group's report was altered slightly to reflect this critique, it did not result in any changes to the major findings or recommendations about the role of ethanol production in meeting this country's liquid fuel needs.

The pessimistic conclusions reached by the Gasohol Study Group are based mainly on the following major errors:

(1) In assessing the impact of ethanol production on food production, the study group failed to consider agricultural feedstocks other than grain crops. However, to avoid competition between food and fuel production, it is essential to introduce alternative crops with a high carbon content. Because they did not evaluate the potential for crop substitution, the study group erroneously concluded that ethanol production could not exceed 800 million gallons per year. Crop substitution would allow for substantially higher levels of ethanol

production without expanding the land devoted to row crops or increasing the environmental impacts of agriculture.

(2) Although concern was expressed over the impact of using crop residues on soil erosion, the study group failed to discuss known agricultural practices which would allow for residue removal without exacerbating soil erosion. The negative conclusion on the possible use of crop residues for fuel production made their net energy gain much lower than otherwise.

(3) In comparing the benefits of ethanol production from grain and methanol production from coal, the Gasohol Study Group grossly understated two problems associated with the latter. First, they failed to emphasize the considerably greater difficulties of blending methanol with gasoline. One solution to these difficulties involves conversion of methanol to gasoline, a process for which Mobil holds a crucial patent. No mention was made of this process in the ERAB report. Second, the study group very tersely mentioned the environmental and social impacts associated with coal conversion technologies, but gave considerable attention to the purported impacts of intensive agriculture. They made no attempt to relate the impacts of coal conversion to the cost of producing methanol.

(4) In assessing the role of on-farm and community ethanol production plants, the study group failed to consider the potential widespread contribution that could be made by mass-produced, factory-assembled units, such as those now being tested by Winnebago Co. Also, there was no discussion of the economies of scale associated with smaller, mass-produced units compared to large-scale facilities.

(5) The study group's evaluation of the cost of ethanol production did not properly consider state-of-the-art technology in the conversion process and the value of fermentation coproducts in reducing the total cost of ethanol production. The report went on to use an analysis by Dr. Paul Weisz and John F. Marshall to determine the "true" price of ethanol production, an analysis which was based on a complete misapplication of the principles of microeconomics.

(6) In assessing the competition between fuel and world food production, the study group failed to properly evaluate the role of U.S. exports in reducing world malnutrition, and to consider how ethanol production in other countries could improve their capability to produce food.

In the sections and appendices that follow, the origins of the errors made in the ERAB Gasohol report, as well as in other recent studies on biomass alcohol production, are explained, in an effort to resolve the disagreements in analysis, and to provide, thereby, a sound basis for a national policy on the production of alcohol fuels.

II. THE WIDE DIVERGENCE AMONG RECENT ESTIMATES OF POTENTIAL ALCOHOL FUELS PRODUCTION

The disagreements between the CBNS analysis and several recent studies of the feasibility of ethanol production from biomass are considerable. Four recent studies—two from the Department of Energy (The Alcohol Fuels Policy Review and the report of the Gasohol Subcommittee of the Energy Research Advisory Board), one from the Office of Technology Assessment and the fourth from the Worldwatch Institute—have generally reached pessimistic conclusions regarding the overall potential for the production of ethanol from agriculture by current, conventional fermentation technology, which may be summarized as follows:

U.S. domestic biomass sources could produce only about 2–12 billion gallons of ethanol per year, or, at most, about 10 percent of the annual demand for gasoline.

Conversion of crops into ethanol can be very inefficient on a net energy basis (with the exception of the OTA estimate), since the yield from the process is at most 5 percent greater than the energy that enters into it. The energy gain only becomes significantly greater (as high as 161 percent) if the process heat input is not counted in cases where it is provided by low-grade fuels, such as coal or crop residues, instead of oil or gas.

Production of ethanol from biomass is more costly than production of methanol from coal or biomass, or of gasoline from petroleum.

Significant production of ethanol from crops in the United States would seriously reduce food supplies and increase food costs, especially in the Third World, and would increase soil loss and chemical pollution from fertilizers and pesticides.

On the contrary, our studies at CBNS have found, with respect to production of ethanol from agricultural crops by means of current fermentation technology, that:

As much as 50 billion gallons of ethanol per year, or nearly half the present gasoline consumption, can be produced in the United States without reducing food or feed production.

With appropriate cultivation practices, ethanol production on this scale would not lead to soil loss or require increased use of fertilizer and pesticides.

Properly calculated, the energy gain in ethanol production from biomass, using currently available technology, is 65 percent of the input energy (rather than 5 percent). If available energy-sparing techniques are used to produce a new crop mix for ethanol production, the energy gain can be increased to about 500 percent.

The cost of a gallon of ethanol is already below the wholesale cost of a gallon of gasoline, if the price of the most expensive barrel of oil is used as a measure. It is certain to fall as improved equipment is introduced. In contrast, estimates of the cost of methanol production from coal have been rising rapidly and are likely to increase beyond the cost of ethanol as the full costs of environmental controls are considered.

There is no inherent conflict between fuel and food production, and, indeed, ethanol production in the Third World may increase food supplies and improve Third World economies.

This contrast between the two groups of analyses remains if the potential of ethanol production based on a new technology which is now approaching economic feasibility—conversion of woody materials, from crop residues and forestry, into sugars which are then fermented to yield alcohol—is considered. Here, the CBNS estimate is about 150 billion gallons of alcohol per year (including about 50 billion gallons of butanediol, an alcohol which is also an effective fuel.) The only other means that has been suggested to produce a comparable magnitude of alcohol fuel from biomass is the thermochemical conversion of cellulosic materials to methanol. However, in contrast to the ethanol-butanediol system which utilizes a biological process to yield alcohol fuel and food coproducts, the pyrolytic conversion of cellulosic materials to methanol does not produce any food coproducts, and necessitates the use of advanced process control technology to handle toxic pyrolytic coproducts such as pyrolysis oil and tar.

Clearly the very existence of such a wide divergence in scientific estimates of potential alcohol fuel production hinders the development of a national policy, and it is important to consider the reasons for this situation.

III. THE IMPORTANCE OF ASKING THE RIGHT QUESTION

In general terms there are three ways that a presumably scientific analysis may arrive at a faulty conclusion: (a) The question addressed by the analysis is inappropriately stated; (b) the data employed in the analysis are inaccurate; (c) the analytical procedures are faulty. The first of these faults is particularly serious since it is likely to result in the use of inappropriate data and analytical procedures as well.

Perhaps the chief reason for the divergence between the analyses which reach pessimistic conclusions about the feasibility of ethanol production from biomass, and the CBNS studies, which reach much more optimistic conclusions, is that they address different questions. Once this fact is appreciated, the apparent discrepancies between the two groups of analyses largely disappear and it becomes evident that the appropriate question leads to the more optimistic conclusions.

Specifically, the studies which reach a pessimistic conclusion attempt to answer the question:

"How much alcohol, at what price, at what cost to environmental quality, and with what impact on the price and availability of food, could be produced from biomass, if the processes that produce it—largely agriculture and forestry—remain in their present form?"

In contrast, the CBNS study, which reaches much more optimistic conclusions, is designed to answer the question:

"How much alcohol, at what price, could be produced from biomass if agricultural and forestry practices were changed with the specific purpose of optimizing both the production of alcohol, and of food and fiber, and at the same time maintaining environmental quality?"

IV. THE IMPORTANCE OF MODIFYING THE CROP-PRODUCING SYSTEM

Perhaps the chief reason the answers to these two questions are so different is that the processes that produce biomass, agriculture in particular, are very

flexible. Thus, in the 1930s Midwestern row crop acreage produced almost entirely corn. Now the same acreage produces, in a much larger total amount, about equal quantities of corn and soybeans. In turn, this change in crops greatly improved their value as livestock nutrients, by sharply raising the total nitrogen content. Thus, if, in the 1930s, the need for livestock production had suddenly increased and the question was asked, "How much more livestock could be produced from Midwestern acreage, accepting its present, nearly total planting to corn?", the answer would be: "Only that amount allowed by the use of idle acres." If, on the other hand, the ability of the acreage to produce crops other than corn were taken into account, then, by introducing soybeans—which are much richer in nutritionally important nitrogen than corn—in place of some of the corn acreage, the nutritive output of livestock products produced on the same acreage could be significantly increased, as indeed it was.

If the inherent flexibility of U.S. agriculture is ignored, as it is in the four studies cited above, then their pessimistic conclusions are inevitable. This can be seen from the following considerations.

1. Approximately two-thirds of the harvested cropland in the United States (largely in the Midwest) is devoted to production of domestic livestock feed. The three principal crops are corn, soybeans and some forages (hay and pasture). In proper combination, these crops contain metabolizable energy (the principal component of which is carbon) and protein (the principal component of which is nitrogen) in a ratio that is—under the pressure of economics—best suited for livestock nutrition.

2. The fuels (ethanol and methane) that can be produced biologically from crops contain carbon, but no nitrogen, and in producing them nearly all of the nitrogen present in the crop biomass remains in the residue (for example, the pulp, distillers grains and solubles remaining from ethanol fermentation). These residues are, therefore, rich in nitrogen and are excellent livestock feeds.

3. Because the present crop system produces biomass that contains the carbon/nitrogen ratio appropriate for livestock nutrition, the use of any of it (apart from waste material not used to raise livestock) to produce ethanol will reduce the carbon content below that required to balance the nitrogen content. That is, since there is no "left-over" carbon available in the crop system for fuel production, if some of it is fermented to produce ethanol the overall nutritive capability of the residue from fermentation will be reduced below that of the original crop. Under these condition, if the biomass used for ethanol production is supplied by crops that would otherwise be used to feed likestock, livestock production—the chief food output of the system—will inevitably be reduced. In other words if food production is not to be reduced, then alcohol can be produced only from waste materials and agricultural residues, and from crops grown on otherwise unused land—a rather limited amount.

The more optimistic CBNS analysis is based on the following, quite different considerations:

1. The foregoing limitation holds only if one accepts the present design of the U.S. crop system—that is, its present carbon/nitrogen ratio embodied in the existing crop mix, that optimizes for livestock production. However, as shown by the example of the introduction of soybeans, the chemical composition, in particular the C/N ratio, of the crops that can be grown on U.S. agricultural lands is by no means fixed and can be rapidly changed by introducing new types of crops and changing the proportions of existing crops.

2. At the present time U.S. livestock agriculture produces about 172 million tons of carbon and 8.1 million tons of nitrogen per year largely in the form of corn, soybeans and hay. Aside from a certain amount of waste, nearly all of this is fed to livestock. So the amount of livestock produced by U.S. agriculture is, so to speak, the amount that can be raised on this much carbon and nitrogen. Under these circumstances, the alcohol that can be produced from crops is limited to that yielded by surplus grain, or by grain grown on otherwise idle land—some 2–12 billion gallons of ethanol per year. The "pessimistic" studies are based on this assumption. Their conclusions regarding the amount of ethanol that can be produced, summarized in Figure I are accordingly low.

3. In contrast, the CBNS studies take advantage of the inherent flexibility of the agricultural system. We can construct a cropping system, based largely on the land available in Midwestern agriculture, that would significantly increase the carbon content of the crop beyond that needed to support the present output of livestock and grain for export. Figure II compares the 1977 conventional crop system with such an alternative system based on a rotation of corn, sugar beets

and forages. The alternative system considerably increases the potential for alcohol production. Thus in 1977 the crop system provided livestock with about 172 million tons of carbon and about eight million tons of nitrogen per year. In contrast, the alternative crop system, based on a corn-sugar beet-forage rotation and the expansion of crop land by 10 percent, would yield about 267 million tons of carbon and about nine million tons of nitrogen per year. In the proposed scheme nearly all of the corn and sugar beet crop is fermented to produce ethanol.

Thus, the new crop system yields about 95 million tons of carbon per year in excess of that needed to maintain present livestock production. Based on the equation for alcohol fermentation ($C_6H_{12}O_6$[glucose]$\rightarrow 2C_2H_5OH$[ethanol] $+2CO_2$[carbon dioxide]), two-thirds of this "excess" carbon could be converted to ethanol by fermentation of the crop starch and sugar. This amounts to about 35 billion gallons of ethanol per year—or about one-third of the present gasoline consumption, based conservatively on the low crop yields of the 1974–76 period. (Corn, for example, averaged only 82 bushels per acre during those years, compared to the subsequent years' yields of 100 bushels per acre.) Based on normal weather conditions and slightly improved yields in the future, grain and sugar crop yields would allow ethanol production to surpass 50 billion gallons per year—or nearly half of the present gasoline consumption.[2]

As shown in Fig. II, the residual material remaining from fermentation of the alternative crop system contains about 179 million tons of carbon, and about nine million tons of nitrogen. This residue (distiller's dried grains and solubles) is an excellent nutrient for livestock production, and since it contains at least as much carbon and nitrogen as the present crop, it can feed as much livestock.

Thus, the chief reason for the divergent conclusions regarding potential ethanol production, is that the four "pessimistic" studies do not take into account the basic fact that the present crop system has been designed, with respect to carbon and nitrogen content, specifically to produce only livestock nutrient. As a result, the current crop system is inherently incapable of supporting ethanol production (apart from the use of waste materials and unused land) without reducing food production.

In contrast, the CBNS approach is to ask how the crop system can be changed to support the dual purpose of producing both food and fuel. Then, taking into account that only carbon is involved in fuel production, whereas food production involves a specific proportion of carbon and nitrogen, a new crop system can be devised that maintains present food productions and yields, as well, an amount of ethanol which is large relative to the present demand for gasoline.

It is evident, then, that a major reason for the discrepancy between the two groups of studies with respect to potential ethanol production is that the "pessimistic" ones were designed to answer the wrong question.

V. THE IMPORTANCE OF APPROPRIATE EVALUATION OF BYPRODUCTS

As noted above, in conventional fermentation technology, the residual material which remains after ethanol (and carbon dioxide) is removed from the biomass contains nearly all the nitrogen originally present in the latter. Also present in the residue is the yeast—the biological fermenting agent—produced during the course of the process. In growing, the yeast converts the simpler nitrogen compounds present in the biomass into protein, thereby contributing to the nutritional value of the residue.

Thus, we can summarize the overall production process as follows: biomass (value: livestock feed)$\rightarrow$ethanol (value: fuel)$+$residue (value: livestock feed).

Clearly the process cannot be properly construed simply as the conversion of livestock feed into fuel. Rather, properly evaluated, the process consists of converting livestock feed into fuel plus some lesser amount of feed. This difference between the two ways of regarding the process leads to different energetic and economic conclusions. For example, if the feed byproduct is ignored, then the energy used to produce the original biomass is regarded as entirely chargeable to the energy requirement for producing ethanol. Since, in fact, about 35 percent of the original nutritive value of grain, for example, is recovered in the residue, the production of alcohol should be charged with only 65 percent of the energy

[2] Even without expanding crop acreage, about 30 billion gallons of ethanol could be produced. (See "Testimony Before Joint Economic Energy Subcommittee," by Richard Carlson. Mar. 17, 1980).

required to produce the biomass. Several early studies (Reilly, 1978 failed to take this into account, and for that reason seriously underestimated the net energy gain from ethanol production. In the same way, the economic value of the fermentation residue must be taken into account in computing the cost of ethanol production.

These considerations become extremely important in evaluating the alcohol fermentation systems based on woody (rather than starch/sugar) feedstocks which are now under development. In these systems biomass that has little or no value as livestock feed is treated to convert its cellulosic constituents into sugars. Cellulose itself is converted into hexose (six-carbon) sugars of the type available from starch in conventional ethanol processes, and the sugars are then fermented in the usual way. Woody materials also contain hemicellulose, which is converted into pentose (five-carbon) sugars. While yeast will not convert pentoses to ethanol, these sugars can be fermented, by certain strains of bacteria, to produce another alcohol—butanediol—which is also an excellent fuel. Finally, the yeast and the bacteria produced during the fermentation processes are protein-rich livestock feeds.

Thus the cellulose systems have the following configuration: woody biomass (value: solid fuel)→ethanol and butanediol (value: liquid fuel)+yeast and bacteria (value: livestock feed).[3]

Once again, if the system is regarded simply as a way of converting cellulose into hexose sugars and the latter into ethanol, the overall process is greatly under-valued. Unfortunately, the significance of the coproducts in cellulose systems has usually been overlooked. For example, none of the "pessimistic" studies cited above considers butanediol production.

A particularly dramatic consequence of ignoring the nutritive value of the coproducts of cellulose fermentation systems relates to the argument, advanced in particular in the Worldwatch Institute report, that extensive alcohol production will reduce food production. When the yeast coproduct is taken into account, it becomes evident that the opposite is true: extensive alcohol production from woody biomass would add significantly to overall food production.

For example, the fermentation of the hexose sugars from the amount of cellulose available annually in woody biomass, agricultural residues, and municipal solid waste in the United States would yield about 14 million tons of yeast—equivalent in nutritive value to all of the soybeans now used as livestock feed in the United States.

Thus if large scale alcohol production from agriculture and woody biomass were established in the United States, it would yield not only fuel equivalent to 150 percent of the present annual gasoline consumption, but in addition enough nutritive material to maintain food and feed production at existing or slightly higher levels.

Once again we see how the much-lamented conflict between alcohol and food production disappears—and turns into its opposite—when the overall system is appreciated in its full complexity.

VI. THE IMPORTANCE OF APPROPRIATE COMPUTATIONS AND SOURCES OF DATA

Another important reason for the apparent discrepancy between the pessimistic and optimistic analyses of ethanol production from biomass is the use, in the pessimistic studies, of inappropriate sources of data and computational procedures, especially in regard to net energy. As shown in Figure III, studies reported in just the last two years differ widely in their computation of the net energy gained in alcohol production from crops. The values range from a net loss of nearly 110,000 Btu's per gallon of ethanol produced (Reilly, 1978) to a net gain of 110,000 Btu's per gallon (CBNS, 1980).

The elements in the computation of net energy gains are: the energy needed to produce and transport the crops (F) and the energy needed to convert the biomass to ethanol (C). The energy outputs are: the energetic value of the ethanol, directly as a fuel (E), and two savings in energy (R). The first saving is accomplished by substituting alcohol for gasoline, because energy is no longer needed to produce gasoline from crude oil (refinery gain). The second saving is the "mechanical advantage"—the energy saved because the work produced by burning gasohol (i.e., the mileage achieved) per unit of energy (as Btu's) contained in the fuel is about 20 percent larger than that produced by gasoline itself.

Net energy can be computed in several different ways.

[3] Yeast is also an excellent human food, a use which considerably enhances its economic value.

(a) Net (1) is computed from the total output of energy less the total input, or: Net (1) = E+R—F—C.

(b) Net (2) is computed without considering the energy required to convert biomass to ethanol, if the latter is a solid fuel (coal, or crop residues rather than oil or natural gas), on the grounds that the value of interest is the net gain in *liquid* fuel. Hence: Net (2) = E+R—F.

If we recall the overall purpose of producing ethanol—that it substitute a renewable, domestic supply of liquid fuel for the increasingly costly nonrenewable supply of gasoline—it becomes evident that the second of these computations (i.e., the determination of Net (2)) is the more relevant one. Given this purpose, the energetic values of the process inputs and outputs are best computed in terms of their renewability. Specifically, the energetic efficiency of the process is best computed from the ratio of the energy value of the renewable fuel produced (ethanol) to the energy value of the nonrenewable fuel that must be used to achieve that production.

The use of nonrenewable fuel in crop production (to drive farm machinery) is essentially unavoidable, so that this figure (F) must enter into the computation. However, the energy needed to operate the process of converting the crop biomass to ethanol can readily be obtained from renewable fuels, such as wood or crop residues. Hence, when the conversion energy (C) is derived from such fuels it is reasonable to exclude it from the computation of net energy gain. For these reasons, of the two forms cited above, the computation of Net (2) (=E+R—F) is the more appropriate way to evaluate the energetic efficiency of ethanol production. Net (2) is, of course, significantly larger than Net (1) (see Figure III) and a good deal of the pessimism about the value of ethanol production derives from the tendency of certain observers (see, for example, Reilly) to emphasize the latter. Again we note that undue pessimism regarding the feasibility of ethanol production arises from unnecessary confusion regarding the appropriateness of alternative methods of computation.

The CBNS analysis has used a different approach, because our study, unlike the others, would change the present crop system to produce both ethanol and food. In this case the net energy gain is computed on a marginal basis—that is, we consider the extra amount of farming energy needed to produce the crops under the revised system (ΔF). Since the values of E, R and C are themselves increments in the revised system, they are inherently marginal values, so that the equations become: Net* (1) = E+R—Δ F—C; and Net* (2) = E+R—Δ F.

Since the crops in the CBNS ethanol/food system require less energy for their cultivation (relative to the yield of ethanol) than the conventional cover crop, ΔF is smaller than F. This accounts, in part, for the relatively low input energy in the CBNS computation, and the relatively high net gain.

Discrepancies in reported net energy gains are chiefly due to the use of inappropriate sources of data or computational procedures. Thus, Reilly's low net energy values can be attributed to (a) the use of biomass conversion data from outmoded, inefficient beverage-alcohol plants which are unnecessary energy-intensive; and (b) the failure to include the refinery gain and the mechanical advantage of ethanol over gasoline (R). In the AFPR study the first of these errors, but not the second, is corrected and the net energy gain is somewhat larger. The ERAB report arrives at relatively low net energy gains (as compared with the OTA and CBNS reports) by using a rather small value for refinery gain, and by eliminating the gain represented by the mechanical advantage of ethanol over gasoline.

Thus the considerable variations in net energy gain reported in recent studies are accountable to the use of inappropriate data (especially in the case of Reilly, 1978), the failure to include relevant variables and the failure (in all studies other than CBNS) to consider the advantages of deliberately revising the agricultural crop system to optimize for the production of both fuel and food.

Finally, the differences between the computation of Net (1) and Net (2), illustrate a considerable energetic advantage in using crop residues as the fuel for the conversion of biomass to ethanol. In this case the energy content of the fuel is largely of solar origin; the investment of one Btu to collect burnable crop residue from the field yields enough biomas to produce 50 Btu's of heat for the ethanol conversion process. Hence one way to ensure a considerable net energy gain in the overall process is to use crop residues as the boiler fuel in the conversion process. In contrast, one can easily arrive at a net loss in energy simply by the expedient of assuming that a valuable liquid fuel, such as oil, is used in the conversion process.

VI. THE IMPORTANCE OF CONSIDERING HISTORICAL TRENDS

One of the generic criticisms of the production of alcohol by fermentation of biomass is that methanol—an equally acceptable alternative liquid fuel—can be produced more cheaply by chemical conversion of coal or biomass. However the two processes—that is, fermentative production of ethanol (and butanediol), and the chemical production of methanol differ considerably in their probable future costs. And since the national policy issue is how to plan for future production of alternative liquid fuels, in comparing these alternatives historical projections of cost must be considered.

The primary reason for expecting different future costs of ethanol and methanol production is their different impacts on environmental and social "externalities." These include the costs of as yet unsolved environmental problems and the cost of community disruptions from the siting of large plants. Ethanol fermentation is an old, well-established technology. Since it is a biological process, its environmental impacts are potentially relatively slight and easily managed. Since it is a well-known technology, the costs of environmental controls are known and have already been entered into production costs. Since ethanol production can be carried out on a relatively small scale (e.g., 150,000 gallons/year, SERI, 1980) almost as efficiently as it can in a very large plant, siting disruptions are readily avoidable.

In contrast, the chemical conversion of coal or biomass into methanol necessitates the production of potentially toxic pollutants. The technology is in an early stage of development and the necessary environmental controls and their costs, are largely uknown. Like most chemical manufacturing plants, methanol coversion plants are large, so that community disruptions from plant sitings are likely.

These considerations suggest that the cost of methanol production is likely to increase with time as the various externalities are evaluated. Meanwhile, the cost of ethanol production is likely to remain constant or to decrease as new, more efficient technologies are introduced. Figure IV indicates, from the estimates reported over recent years, that these different historic trends do, in fact, occur. Although at present the estimated cost of methanol production from coal is about one-third less than that of ethanol production, if recent trends continue (and given the numerous as yet unevaluated externalities they are likely to), the costs will become equal in the next few years.

In comparing the cost of producing ethanol with the cost of gasoline, the following considerations are relevant. The current wholesale price of ethanol (about $1.85 per gallon), while high compared to the wholesale price of gasoline (about $0.85 per gallon), is artificially elevated by the present ethanol demand. According to a report by Ralph Katzen Associates, (Katzen, 1979) ethanol can be produced profitably from corn (at $2.30 per bushel) for $0.89–1.15 per gallon. On a heat of combustion basis this cost is equivalent, compared with a gallon of gasoline to $1.34–1.74 per gallon of ethanol. However, a good part of the value of ethanol, as an automotive fuel, is based on its value as an octane booster, and its "mechanical advantage" over gasoline. According to the OTA report these two factors add about $0.35–0.45 to the value of a gallon of ethanol. Taking these factors into account it would appear that the present market value of alcohol is about $1 per gallon, or approximately equal to its cost of production.

As noted earlier, in terms of national policy, what is relevant is the future relation between the cost of ethanol from biomass and gasoline. Because gasoline (whether produced from natural crude oil or as a synthetic fuel derived from shale or coal) is a nonrenewable fuel, it is subject to an exponential rise in production costs as supplies diminish. In contrast, for the reasons cited earlier, ethanol produced from biomass is a renewable, solar fuel and, therefore, likely to remain constant or even to decline, in cost. Hence, ethanol from biomass will become progressively more economical than gasoline and, therefore, a cost-effective substitute for it.

It seems clear that if these relationships are ignored, comparative cost estimates may be quite awry. This is evident, for example, in the ERAB report which totally ignores the considerable environmental problems in methanol production from coal, while emphasizing the much milder (and already cost-evaluated) ones associated with ethanol production.

VII. THE IMPORTANCE OF CONSIDERING ENVIRONMENTALLY AND ENERGETICALLY SOUND TECHNOLOGIES

Another reason for the divergence between the optimistic and pessimistic conclusions about the value of alcohol production from biomass, especially from agricultural crops, reflects the truism that it is always possible to do an inherently good thing badly. The pessimistic studies claim that since present agricultural practice in the United States is heavily dependent on energy-intensive inputs of fuel and agricultural chemicals, and exacts a heavy penalty on environmental quality, the introduction of more intensive agriculture for the sake of alcohol production would worsen both of these difficulties. The fault in this conclusion is that the present energetic and environmental impact of U.S. agriculture is unnecessarily high. Reliance on such faulty agricultural technology to produce alcohol is simply choosing a bad way to carry out the process, with the inevitable result that its outcome will be bad.

The most direct evidence on this point is contained in a series of studies (Lockeretz et al, 1978 and 1980) by CBNS in which large, commercial Midwestern (organic) farms which do not use energy-intensive agricultural chemicals such as inorganic nitrogen fertilizer and pesticides were compared, over a five year period with otherwise similar conventional farms. The organic farms' yields averaged about eleven percent less than those of the conventional farms. However, since they had eliminated expenditures for agricultural chemicals, the net economic returns per acre of crop achieved by the organic farms were equal to those of the conventional farms. Most relevant to the present considerations is the observation that the energy expended per unit of crop produced by the organic farms was only 35% of the conventional farms' energy expenditure. Moreover, the soil of the organic farms contained significantly more organic matter—an important factor in maintaining the ecological integrity of soil—than that of the conventional farms. These practices, together wtih other energy saving techniques such as conservation cultivation, can considerably reduce the energy required to produce crops, and hence improve net energy yield from alcohol production.

It is particularly relevant to note that new agricultural practices that are less energy-intensive than conventional ones are also less stressful to the environment. Thus if we take into account these potential improvements in agricultural practice—rather than accepting the present energetically- and environmentally-faulty practices as fixed—it is possible to avoid undue environmental effects from large-scale ethanol production from biomass and to improve its net energy yield. Against this background dire predictions such as the following, in the Worldwatch report #35 (Brown, 1980) seem unwarranted:

"With the demand for food projected to double again over the next generation, it will be difficult to lighten the demands on soils and to arrest their long-term deterioration. If, in addition, vast areas are planted to energy crops, the problem will become even more unmanageable."

This statement is true only if one accepts the immutability of the present, faculty agricultural practices. A more constructive approach is to recognize that, even in the absence of agricultural energy production, these practices must be rectified if the capability of the earth's surface to sustain the human population is to continue. The new potential for devoting agriculture to the production of both food and fuel can then be seen as an historic opportunity to, at last, develop an ecologically sound system of modern agriculture.

VIII. CONCLUSIONS AND POLICY CONSIDERATIONS

The policy question under consideration here is the feasibility of replacing the nonrenewable liquid fuels on which we now depend with renewable solar fuels. The most important conclusion to be derived from the foregoing considerations is that it is quite feasible to produce sufficient liquid fuel from renewable biomass—in the form of fermentation-produced ethanol and butanediol *or* thermochemically-produced methanol—to more than meet the present demand for gasoline (which represents about 50 percent of total oil consumption). With the adoption of available, appropriate methods of cultivation, and by appropriately

revising the present pattern of crop production, this amount of renewable fuel could be produced from biomass without reducing food and fiber production and without intensifying the environmental impact of agriculture. Finally, properly computed, the energetic advantage of producing such liquid fuels from biomass is considerable, and their cost (relative to the cost of gasoline, or of methanol and other synthetic fuels produced from coal) is certain to become progressively more advantageous.

In sum, the pessimistic claims that production of renewable fuels such as ethanol from biomass is impossible without severely reducing food production and intensifying environmental degradation are unwarranted. It should be noted, however, that it is possible to find support for such claims—but only by failing to properly integrate alcohol production into a revised system of agriculture that is designed deliberately to optimize the production of fuel as well as food and fiber and by failing to employ energetically and environmentally sound cultivation practices.

This conclusion has far-reaching consequences for national energy policy:

First, it indicates that the current program, now under consideration in the Congress, to establish massive programs for the production of synthetic liquid fuels from coal and shale oil is unnecessary. Alcohol production from biomass represents an alternative to such synthetic fuels that is renewable, more benign environmentally, more readily established in decentralized small-scale operations, less capital intensive, and therefore less socially disruptive.

Second, the effective deployment of alcohol production from biomass on such a large scale calls for more active public governance of the oil and automotive industries. If alcohol is produced in small amounts (on the order of two billion gallons per year) no significant policy changes would be required. But large-scale alcohol production would require matching the characteristics of oil refinery products to the increasing production of biomass alcohol, and of engine designs to the changing ratio of alcohol and gasoline, as the former gradually replaces the latter.

Third, large-scale ethanol production requires an agricultural policy which is deliberately designed to promote market shifts and changing crop mixes in order to achieve the full technical potential of alcohol production without diminishing aggregate food production.

Fourth, the key step that must be taken to initiate fermentative production of alcohol from biomass is to provide farmers with suitably-scaled production facilities, stills and associated equipment in particular. This calls for the establishment of large-scale manufacturing plants for such equipment.

Fifth, with respect to the relative emphasis on fermentative production of ethanol (and eventually of butanediol) from biomass, and the thermochemical production of methanol from biomass sources, consideration should be given to their respective advantages in different regions of the country. It should be possible to use all three types of alcohol as concurrent substitutes for gasoline, and the relative importance given to their production might best be guided by the specific features of a given region's system of biomass production and by social considerations regarding the appropriate scale of such operations.

On the basis of these considerations the following specific policy steps are recommended:

(1) Establishing, as a matter of government policy, that the total present use of gasoline will be replaced, as expeditiously as possible, by alcohol produced from biomass.

(2) Cancellation of the programs for production of synthetic liquid fuels from coal and shale oil, now under consideration in the Congress.

(3) Establishing an agricultural policy geared to facilitating the new crop systems and cultivation practices essential to the production of alcohol from agricultural biomass without interfering with food production or diminishing environmental quality.

(4) Requiring automakers to produce cars capable of operating on 100 percent alcohol by 1990 or 2000, and before then to produce engines capable of running on a wide range of alcohol-gasoline mixtures.

(5) Creating a massive program for producing energy-saving alcohol stills of a size suitable for on-farm or farmers' cooperative use. It would be particularly appropriate to provide public funds to enable automobile plants—so many of which are now being closed—to be converted to the production of the stills and related equipment needed for a large-scale alcohol production program.

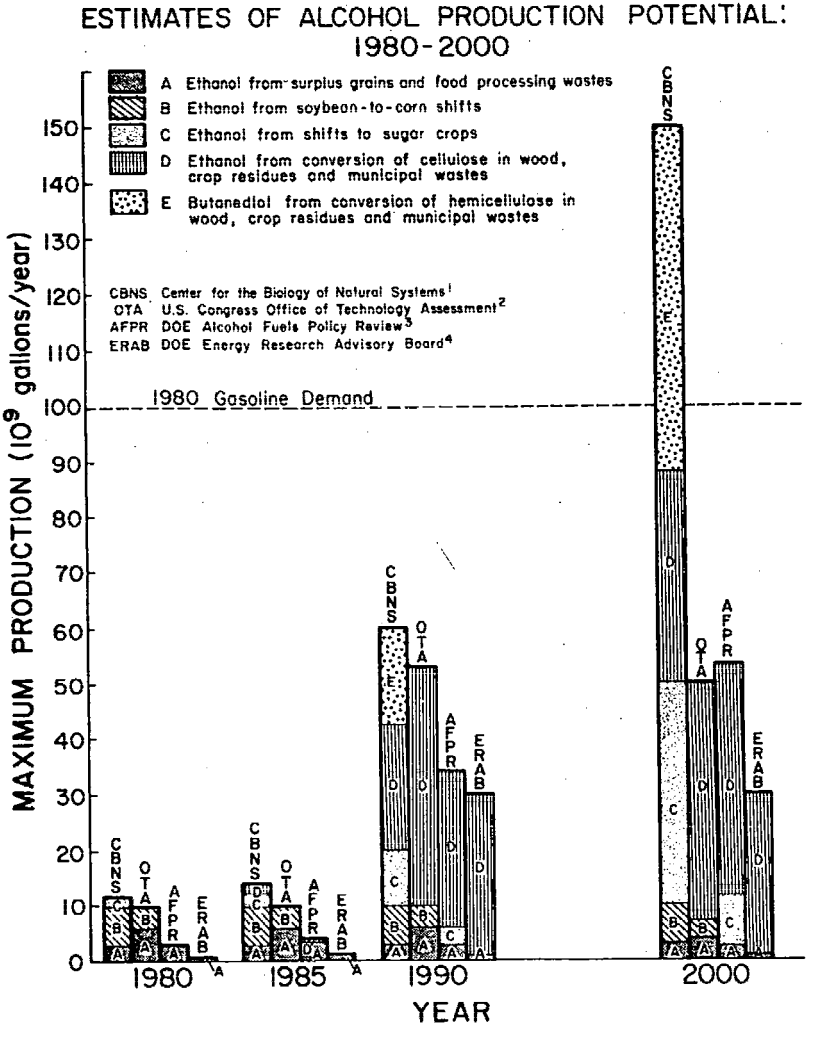
ESTIMATES OF ALCOHOL PRODUCTION POTENTIAL: 1980-2000
A Ethanol from surplus grains and food processing wastes
B Ethanol from soybean-to-corn shifts
C Ethanol from shifts to sugar crops
D Ethanol from conversion of cellulose in wood, crop residues and municipal wastes
E Butanediol from conversion of hemicellulose in wood, crop residues and municipal wastes
CBNS Center for the Biology of Natural Systems[1]
OTA U.S. Congress Office of Technology Assessment[2]
AFPR DOE Alcohol Fuels Policy Review[3]
ERAB DOE Energy Research Advisory Board[4]
1980 Gasoline Demand
MAXIMUM PRODUCTION (10^9 gallons/year)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
CBNS
OTA
AFPR
ERAB
1980
1985
1990
2000
YEAR

FIGURE I

SOURCES TO FIGURE I

1. CBNS (Center for the Biology of Natural Systems): These estimates are derived from Richard Carlson, "Integrated Food-Energy Production Analysis," Testimony before the Joint Economic Committee of the U.S. Congress, Subcommittee on Energy (St. Louis, Missouri: Center for the Biology of Natural Systems, Washington University; Mar. 17, 1980) and from unpublished data derived from the CBNS model of optimal agricultural systems for production of food and energy.

2. OTA (U.S. Congress Office of Technology Assessment): These estimates are from "Gasohol: A Technical Memorandum," Office of Technology Assessment (Washington, D.C.: U.S. Government Printing Office; September 1979). Category A resources include food processing wastes and spoiled grain, with no new land brought into production and with minimal crop substitution. The following resources are split between Categories A and B: An additional 4–6 billion gallons possible from (i) new potential cropland and conversion of cropland pasture to grow feedstocks (land not needed for food, feed, fiber=30 million acres); (ii) use of set-aside and diverted cropland (p. 29). Another 3–5 billion possible if DDG produced is substituted for soybean meal, allowing some soybean acreage to go into ethanol feedstock production (p. 30). Finally, note that A and B are reduced in 2000 because OTA states that less than 10 billion gallons would be produced after 1990 because of increased competition for land for food production (p. 30). For Category D, OTA also estimates that at least 43 billion gallons of ethanol could be produced from cellulosic material (p. 31). Where a range is indicated, the midpoint is indicated in this figure.

3. AFPR (DOE Alcohol Fuels Policy Review): U.S. Department of Energy, Assistant Secretary for Policy Evaluation, "Report of the Alcohol Fuels Policy Review" (Washington, D.C.: U.S. Government Printing Office; June 1979). Category A included 210 million gallons per year which could be produced from available surplus waste grains, with no use of any set-aside acreage (p. 47). In addition, another 240 to 450 million gallons could be immediately produced from food processing wastes (p. 46 and 47). Finally, Category A includes another 2.84 to 3.05 billion gallons which could be produced if: (i) all set-aside acres could be used, (ii) no allowance were made for a USDA reserve margin for grain, (iv) no change were allowed in food/feed supply or exports (pp. 45, 46). Category C includes: (i) for 1985, 150 mm from sugar cane, 260 mm from sweet sorghum (p. 46); (ii) from 1990, 720 mm from sugar cane and 2.95 billion from sweet sorghum; (iii) for 2000, 720 mm from sugar cane and 8.3 billion from sweet sorghum (p. 46). For 1990 AFPR estimates that 34 billion gallons of ethanol could be produced from cellulosics (Category D), including 20.2 billion gallons from wood; 11.3 billion gallons from agricultural residues; and 2.5 billion gallons from Municipal solid waste (MSW). For 2000 APFR estimates that 41.8 billion gallons of ethanol could be produced from cellulosics, including 25.8 billion gallons from wood, 13.3 billion gallons from agricultural residues and 2.9 billion gallons from MSW.

4. ERAB (DOE Energy Research Advisory Board): The DOE Gasohol Study Group (David Pimentel, et al) "Report of the Energy Research Advisory Board on Gasohol" (manuscript, Washington, D.C.: U.S. Department of Energy; April 29, 1980). The ERAB report estimates that before 1985 ethanol production will be limited to 200–300 million gallons per year from Category A materials, assuming no oil or gas is used in distillation. After 1985, the maximum potential for producing ethanol from grains (Category A) will be 800 million gallons per year, based on using 9 million tons of surplus grain. ERAB estimates that after 1990 methanol from coal or ethanol from cellulose will become major fuels (pp 10, 13) with the advent of cellulosic technology. They estimate that category D (cellulosic conversion) resources could include: 70 percent of the corn residue from 20 percent of corn land, and 43 percent of residue from 25 percent of land in wheat; wood forestry residues: and 60 million acres of forestland converted to fuel wood farms, yielding a total of 18.6 billion gallons of ethanol (p. 26).

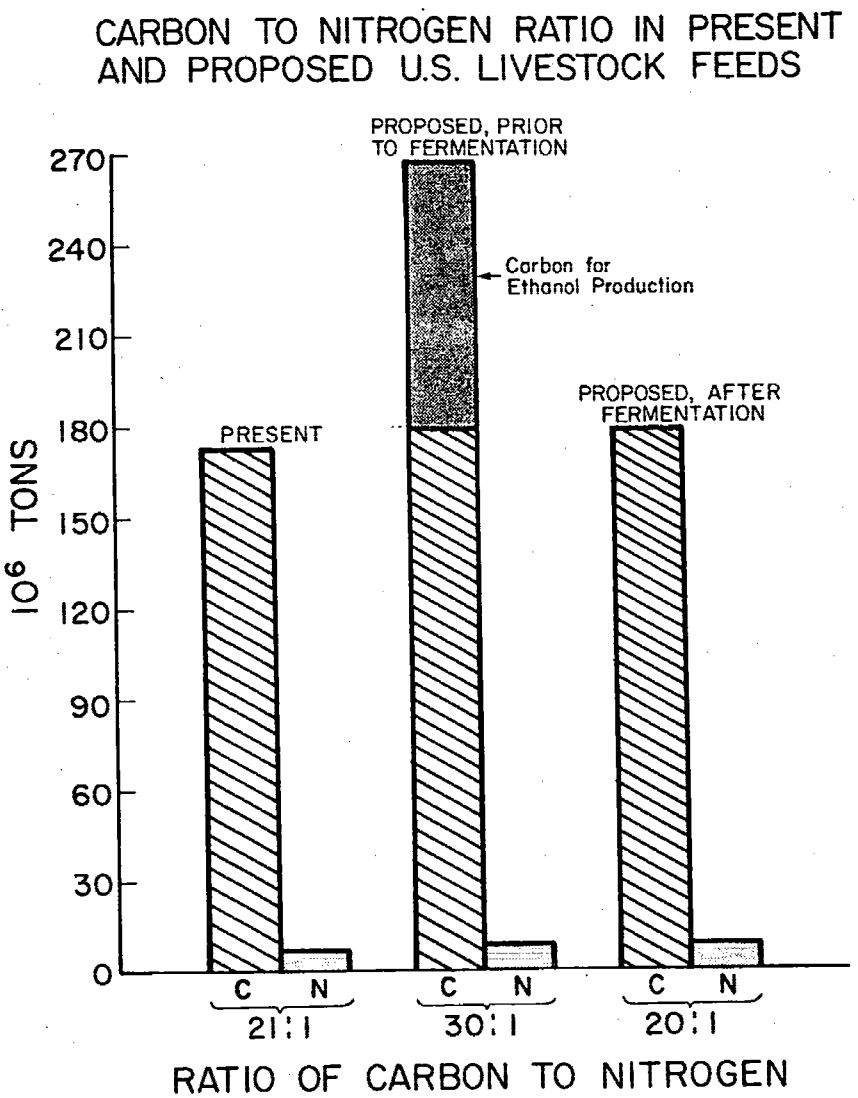
CARBON TO NITROGEN RATIO IN PRESENT AND PROPOSED U.S. LIVESTOCK FEEDS
PROPOSED, PRIOR TO FERMENTATION
Carbon for Ethanol Production
PROPOSED, AFTER FERMENTATION
PRESENT
270
240
210
180
150
120
90
60
30
0
10⁶ TONS
C N
C N
C N
21:1
30:1
20:1
RATIO OF CARBON TO NITROGEN

FIGURE II

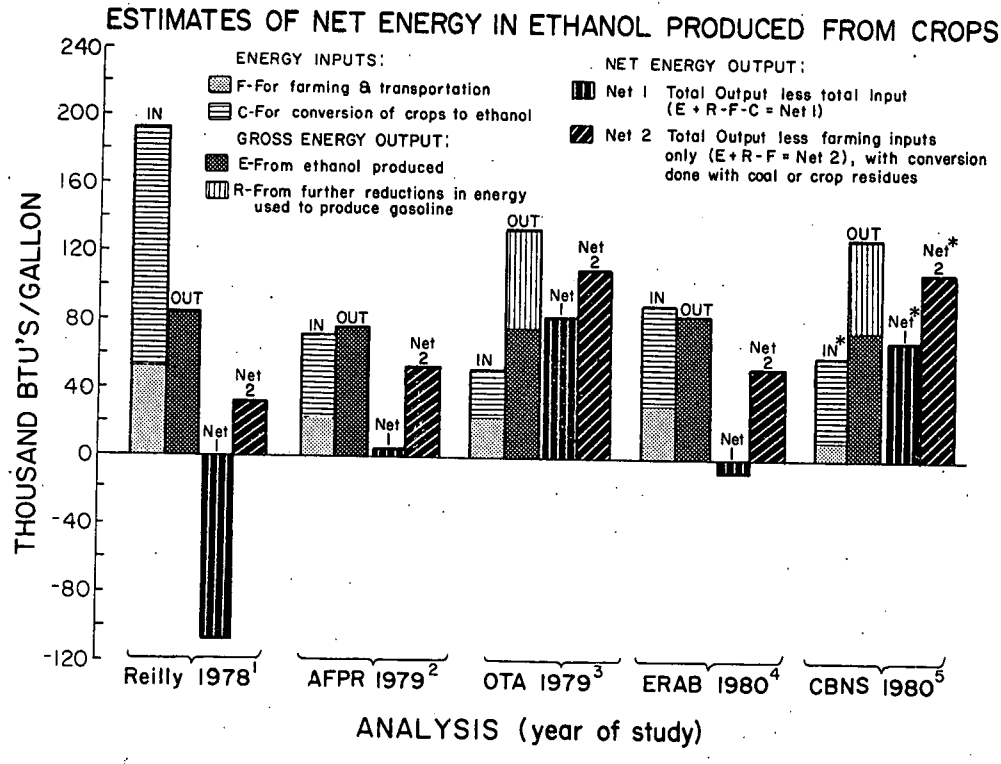

FIGURE III

*The CBNS analysis is based on the increment in energy used in a new cropping system to produce crops for conversion to ethanol, and thus differs from the other analyses cited here. See sources below for further details.

SOURCES TO FIGURE III

1. Reilly, 1978: Reilly, Peter J., "Economics and Energy Requirements of Ethanol Production," Department of Chemical Engineering and Nuclear Engineering, Iowa State University, January 1978. This study did not allocate any credit to farm energy consumption for the distiller's grains coproduct in the energy input/output estimates (pp. 5, 7). The conversion energy component is high (140,000 Btu's/gallon), which reflects the range of estimates commonly associated with inefficient brewing technologies, rather than with state-of-the-art fuel alcohol distilleries.

2. AFPR, 1979: U.S. Department of Energy, Assistant Secretary for Policy Evaluation, "Report of the Alcohol Fuels Policy Review" (Washington, D.C.: U.S. Government Printing Office; June 1979). A farming energy credit of 11,800 Btu for the distiller's grain product was deducted from the total farming energy estimate of 36,980 Btu to get the amount shown in Figure 3.

3. OTA, 1979: U.S. Congress, Office of Technology Assessment, "Gasohol: A Technical Memorandum" (Washington, D.C.: U.S. Government Printing Office; September 1979). The OTA study adds energy credits to ethanol as follows: 42,120 Btu are added to account for the refinery credit resulting from ETOH's octane boosting properties and the refinery energy saved in not producing the gasoline replaced by ETOH fuel. As a further credit, 17,600 Btu were added to reflect an estimated 20 percent increase in mileage pet Btu of ETOH used (p. 16). A credit for farming energy input to distiller's grains of 10,530 Btu was deducted from total farming energy input estimated at 33,930 Btu.

4. ERAB, 1980: The DOE Gasohol Study Group (David Pimentel, et al.). "Report of the Energy Research Advisory Board on Gasohol" (manuscript, Washington, D.C.: U.S. Department of Energy; April 29, 1980). The estimated farming energy input to distiller's grains was 11,000 Btu, and was deducted from the total farming energy estimate of 45,000 Btu. A refinery energy credit of 8,000 Btu reflects reduced energy input to refining gasoline replaced by ETOH fuel (p. 25).

5. CBNS, 1980: These estimates are derived from Carlson, Richard, in Testimony before the Energy Subcommittee of the Joint Economic Committee of the U.S. Congress on "Integrated Food-Energy Production Analysis" (St. Louis, Missouri: Center for the Biology of Natural Systems, Washington University; March 17, 1980), CBNS–AEP–12. As noted on Figure 3, the CBNS method for computing energy inputs to farming for energy crops differs substantially from the other methods cited there. The CBNS approach is based on a systematic analysis of agricultural production patterns which has described an alternative system of cropping which would increase production of energy crops without reducing the production of vegetable protein for livestock. Hence, the CBNS energy analysis is based on the amount of energy needed to obtain the increment in crop output, above current levels of agricultural production. This explains why the CBNS estimate of farm energy use is less than half that of the other studies cited above.

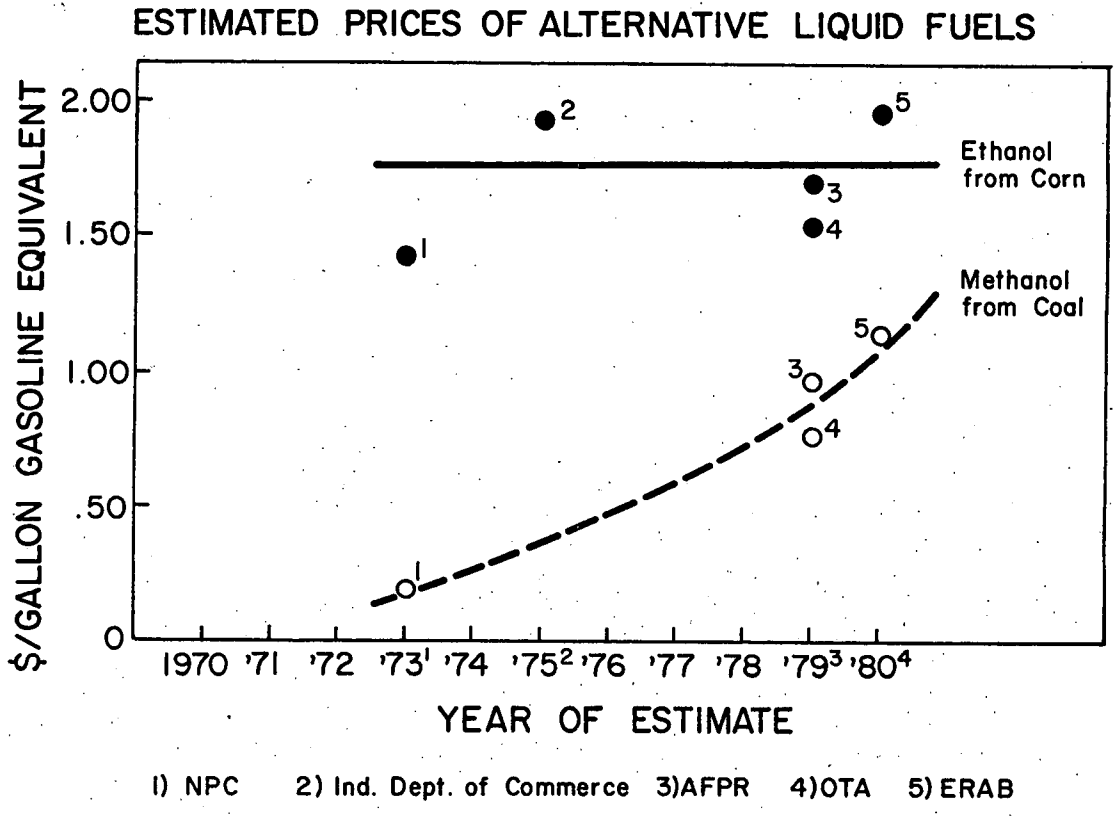
ESTIMATED PRICES OF ALTERNATIVE LIQUID FUELS
$/GALLON GASOLINE EQUIVALENT
2.00
1.50
1.00
.50
0
Ethanol from Corn
Methanol from Coal
1970 '71 '72 '73 '74 '75 '76 '77 '78 '79 '80
YEAR OF ESTIMATE
1) NPC 2) Ind. Dept. of Commerce 3)AFPR 4)OTA 5) ERAB

FIGURE IV

SOURCES TO FIGURE IV

All costs are expressed in current dollars, as of the date of the study. Method for computing gallons of gasoline equivalent: 1 gallon of typical gasoline has 115,400 Btu; 200 proof ethanol (ETOH) has 75,670 Btu per gallon, 200 proof methanol (MEOH) has 56,560 Btu per gallon. On a gasoline equivalent basis: 1 gal. gasoline=1.525 gal. ETOH=2.040 gal. MEOH.

No energy credits are included to account for the increased energy value/Btu for ETOH and MEOH which can result from their octane boosting and improved mileage properties as gasoline substitutes. Source of Btu values: Alcohols: A Technical Assessment of Their Application as Fuels (Washington, D.C.: American Petroleum Institute; July 1976), p. 8.

1. NPC: National Petroleum Council, "U.S. Energy Outlook: New Energy Forms" A Report of the New Energy Forms Task Group of the Other Energy Resources Subcommittee of the National Petroleum Council's Subcommittee on U.S. Energy Outlook (Washington, D.C.: National Petroleum Council; 1973). 1973 methanol estimate based on coal costing $3.50 to $15.00 per ton in 1973 dollars (pp. 161–165). Ethanol cost includes 1973 corn feedstock cost (at $2.00/bu, or $.74/gal with 1 bu yielding 2.7 gallons ethanol, and a conversion cost of 10.2¢/gal; a correction factor for profit margin and marketing expenses of 15¢/gallon has been added in this figure and a credit for distiller's grains sale is taken (p. 78, 79). Source of ethanol cost estimate: Dwight L. Miller, "Corn and Its Uses," National Corn Growers Association, April 5, 1972; updated to May 1973.

2. Ind. Dept. of Commerce: Long-Rock J. V., "Grain Alcohol Study," manuscript prepared for the Indiana State Department of Commerce, July 1975. Credit is taken for sale of distiller's grains, Esteraldehyde fraction fuel, fusil oil and CO_2 coproducts; a 20 percent profit margin is included (pp. 10, 11).

3. AFPR: "The Report of the Alcohol Fuels Policy Review," U.S. Department of Energy, Assistant Secretary for Policy Evaluation (Washington, D.C.: U.S. Government Printing Office; June 1979). The ethanol cost estimate is based on a discounted cash flow return of 15–20 percent, and a 50 million gallon per year plant capacity with coal providing process heat (p. 72). The methanol cost estimate reflects an average cost (in 1978 dollars) of coal, a 15–12 percent discounted cash flow return, and a plant capacity ranging from 650 to 723 million gallons per year (p. 72).

4. OTA: U.S. Office of Technology Assessment, "Gasohol: A Technical Memorandum" (Washington, D.C.: U.S. Government Printing Office; September 1979). Ethanol estimate refers to a 50 million gallon per year plant and a 13 percent return on investment, coal supplies process energy, and includes the cost of drying the distiller's grains coproduct. The corn feedstock cost was estimated at $2.44 per bushel—an average of 1974–1977 prices (pp. 20, 21 and 22).

5. "Report of the Energy Research Advisory Board on Gasohol," prepared by the DOE Gasohol Study Group (manuscript, Washington, D.C.: U.S. Department of Energy; April 29, 1980). The ethanol estimate given is an average of a low estimate given in the text (p. 14) and a high estimate presented in a later figure (p. 28). Sale of coproducts and a return rate is not included in the higher estimate for manufacturing costs associated with a coal-fired, 50 million gallon per year conversion plant. The conversion technology is defined as the best potentially available through 1985. The methanol estimate derives from Stanford Research Institute data for 1978 and 1979, and averages the cost for lignite and bituminous coal. A 15 percent discount rate was used for a plant producing 735 million gallons per year of methanol.

APPENDIX I

A CRITIQUE OF THE DECEMBER 20, 1979 DRAFT REPORT, "GASOHOL STUDY," OF THE GASOHOL STUDY GROUP, ENERGY RESEARCH ADVISORY BOARD, U.S. DEPARTMENT OF ENERGY, JANUARY 16, 1980

PREFACE

The following brief critique of the December 20, 1979, draft report of the Gasohol Study Group of the DOE Energy Research Advisory Board was intended to highlight several distortions and omissions in the study. The point considered in this critique are:

(1) The failure of the agricultural analysis to consider (a) using starch and sugar crops other than grains for ethanol conversion, or (b) alternative crop production techniques which minimize agricultural inputs and soil loss;

(2) The lack of balance in the methanol-ethanol comparison through (a) the failure to consider the greater difficulties in blending methanol with gasoline than in blending ethanol with gasoline and (b) the complete omission of the environmental damages associated with methanol produced from coal;

(3) The pessimistic analysis of the energy cost of producing ethanol from grain;

(4) The minimizing of the potential role of small on-farm scale ethanol plants compared to larger distilleries;

(5) The inadequate analysis of the role of U.S. grain exports in meeting world food needs; and

(6) The incorrect economic analysis of the cost of net high-grade fuel production by grain ethanol.

This critique was presented at the February 8, 1980, meeting of the Energy Research and Advisory Board (ERAB) by Richard Carlson and submitted for inclusion into the Board's written record. It has been left in its original form to facilitate an assessment of ERAB's responsiveness to this public input. The final April 29, 1980, Gasohol report of ERAB was slightly altered to include in its findings that (1) alternative agricultural systems should be analyzed in terms of their potential to produce food and ethanol; (2) methanol causes greater automobile problems than ethanol in gasoline blends; (3) that coal to methanol conversion potentially results in environmental problems. The remaining points made in this critique of the draft ERAB Gasohol report were not addressed in the findings of the final version. In general, however, no changes were made in the basic conclusion of the report that ethanol from agricultural crops should play a very minor role in filling the nation's future liquid fuel needs.

1. IMPACTS ON AGRICULTURE

The Study Group failed to adequately consider the range of impacts that ethanol production could have on agriculture chiefly because they omitted consideration of using any agricultural feedstock other than grain crops. This omission led them to underestimate the land available for alcohol production, to overrate the impacts a large ethanol production effort will have on food prices and supply, and to overstate the potential for land degradation arising from alcohol production. Further, the estimate of the potential for land deterioration itself is biased by a failure to consider the effects of new trends in grain crop cultivation techniques, such as low- or no-tillage methods and the substitution of legume rotations for inorganic nitrogen fertilizer (which increases the organic content and stability of the soil)—practices which may greatly relieve the rate of soil and soil-nutrient losses being experienced with current agricultural practices.

Thus, the statement (p. 15) that, ". . . because livestock and gasohol production use the same resource, they will compete for surplus grain . . ." only reflects the Study Group's failure to consider alternative ethanol production schemes that involve an integration of alcohol and feed production through the introduction of alternative crops with a high carbon content. Among the members of alternative crops with a high carbon content. Among the members of the Study Group, at least Drs. Pimentel and Weisz were aware of the possibilities for such integration, for we discussed them at some length with a group of Mobil Company officials, which included Dr. Weisz and Dr. Pimentel (the latter present as a consultant to the group) in a meeting at CBNS on October 4, 1979.

The Study Group's projection (p. 16) of limited land availability for alcohol production due to variances in set-aside acreage, and the conflict of using mar-

ginal lands for grazing or grain-crop cultivation is predicated entirely on their postulation that only grain crops will be used in fermentation. Additionally, the statement (p. 16) that "Raising grains and corn in particular with current agricultural technology degrades the soil . . .," while formally correct, fails to reflect the evidence that new agricultural practices, such as minimum tillage and the use of legume rotations can, in fact, solve this problem.

2. COMPARISON BETWEEN ETHANOL AND METHANOL

One of the questions the Gasohol Study Group was asked to investigate was, "What are the comparative benefits of ethanol production from grain and methanol production from coal?" Their draft report is grossly deficient in its analysis of this question in the following respects:

(a) One of the report's findings is "Methanol as well as ethanol contributes some problems in automobile operation." This is true, but it disguises the fact that methanol presents much more serious problems in blends with gasoline than does ethanol. Although there is some controversy over how much greater the problems are with using methanol in blends, the fact remains that ethanol is chemically more similar than methanol to gasoline and therefore causes fewer problems in blends that are used in unmodified, production line automobiles designed to run on straight gasoline. The key areas in which methanol frequently performs less well in blends than ethanol are:

Solubility: methanol is less soluble in gasoline than ethanol and is more likely to separate from gasoline in the presence of water;

Corrosiveness: both alcohols can be corrosive to some parts (e.g., rubber) in the fuel system, but the effect is most severe when phase separation occurs (which is more likely with methanol) because the alcohol then becomes more concentrated;

Leaning: methanol causes more leaning than ethanol blends of the same percentage. Although some leaning effect may be desirable, excessive leaning can cause problems such as hard starting, poor acceleration, hesitation, and stalling.

The relatively greater problems of blending methanol with gasoline, compared to ethanol, has prompted research to find ways of attenuating these problems. One approach, not mentioned at all in the report, is the conversion of methanol directly to high octane gasoline. The Mobil Oil Company holds a patent on this process, which apparently solves the blending problems, but results in a loss of about 35 percent of the heat of combustion energy in the methanol feedstock. Thus, there is a trade-off between solving the blending problems and the energetic efficiency of methanol—a problem which does not occur with ethanol.

In sum, although both alcohols cause some problems in automobile operation, the problems of using methanol in blends with basoline are so much more acute as to invalidate the apparently even-handed comparison, quoted above, in the Study Group report.

(b) It is noteworthy that the Study Group's emphasis on the potential environmental impacts of a grain-based gasohol program is not matched by a discussion of the environmental impacts which would arise from their recommendation for future reliance on methanol from coal. In fact, the report makes no mention of possible damage to the environment from methanol production, although these are well known: land damage, air and water pollution and CO_2 build-up. The discussion of coal-derived methanol only presents favorable estimates of technological capability and end-product cost, in contrast with the overly pessimistic estimates for ethanol production. In these respects the report's comparative consideration of ethanol and methanol is seriously imbalanced.

3. ENERGY BALANCE

The Study Group report claims that existing fermentation and distillation technology with plants using oil or natural gas for process heat results in no net energy gain, while plants designed to use coal of biomass sources for boiler fuel would produce ethanol with a net energy gain equivalent to .5 gallon gasoline per gallon of ethanol produced. No source is given for these conclusions or for the energy balance figures in Table 1 of the report. Nevertheless, the literature contains data which lead to more favorable estimates of the net energy balance. For example, Rephael Katzen Inc.[1] and a study by the Office of Technology

[1] Katzen, Raphael, and Associates, "Grain Motor Fuel Alcohol Technical and Economic Assessment Study," prepared for U.S. Department of Energy (June 1979) HCP/J6639–01.

Assessment[2] present fermentation process and farming energy inputs which are one-third less than the values cited in the report. Whereas most reports in the literature allow stillage an energy equivalent (or credit), proportional to its feed value, which is one-third to one-half the value of the gross grain feedstock, Table 1 of the report only gives a stillage value of one-fourth the original grain value. The refinery energy credit in Table 1 only represents at 10 percent refinery energy loss, which may be accurate for the average of the whole petroleum product slate. However, various reports have found that the production of gasoline (which is the refinery product relevant to this discussion) is two to three times more energy-intensive than the average for all products. Hence, the refinery loss cited by the report is too low, again contributing to its pessimistic conclusion about the energetic efficiency of ethanol production.

Finally, the report errs in basing the energetic efficiency of ethanol production on its heating value, rather than on its mechanical value. It is well known that the actual effectiveness of ethanol in gasohol reflects its octane rating as well as its thermodynamic properties, so that its mechanical value is higher than its heat value, and is the more appropriate basis for evaluating the energetic efficency of ethanol. Although this fact is alluded to parenthetically on page 22 of the report, it is not reflected in the report's conclusions which therefore underestimate the energistic efficiency of the process. As we have shown (CBNS–AEP–6; Table 5), the net energy gain for ethanol in gasohol, including all fermentation and distallation process energy using oil or natural gas as fuel, is equivalent to 0.4 gallons of gasoline, in comparison with the report's estimate of zero net energy gain if oil or natural gas is used. Advances in both conversion technology and the widespread use of existing energy-saving farming methods could further increase the net energy gain. And if renewable feedstocks or coal is used as the process energy, the net gain may be doubled—to .8 gallon gasoline-equivalent.

4. POTENTIAL FOR ON-FARM ETHANOL PRODUCTION

The report states that farm distilleries "* * * are not likely to have a significant impact on gasoline supply." This statement is not consistent with current technological and economic developments in on-farm ethanol production plants. The emerging economics of on-farm facilities suggest that plants of this size will have a capacity to produce fuel several times in excess of the farm's own liquid fuel needs. Although smaller-size plants are being considered, many current manufacturers of small-scale distilleries are offering systems with capacities of at least 20 gallons of anhydrous ethanol per hour, due to economics of scale in various pieces of equipment. Operating 6,500 hours per year (about three-quarters of total available hours), such a plant would produce 130,000 gpy—far in excess of the fuel needs of most individual farms. The sum of production from thousands of individual farms has the potential for contributing billions of gallons to the nation's liquid fuel supply.

The major classes of livestock which utilize high-protein feed concentrates are dairy, poultry, hogs, and beef feeders. Virtually all dairy production, most hog production, and about half of cattle fattening occurs on family farm size operations where the bulk of the feed is produced on-farm. Poultry production and the remainder of cattle fattening is performed in large operations which purchase most or all of their feed. Dairy, hog and beef family farms have three sources of small-scale economies of ethanol production: (1) an immediate, reliable outlet for wet or condensed stillage which eliminates expensive and energy-consumptive stillage drying, (2) feedstock and stillage transportation costs are eliminated, and (3) availability and reliability of crop residues or livestock manure for process heat. In contrast, large-scale ethanol plants will have to carry the expense of drying and transporting the leftover stillage, since it will be unlikely they will be able to secure a large, continuous local demand for their wet feed byproduct.

5. COMPETITION FOR THE GRAIN RESOURCE

The Study Group report contends that the growing world population, the nearly full utilization of the world's cropland, and the lack of increasing world crop yields all imply an ever-growing foreign demand for U.S. grain, with a concomitant rise in its price over time. While it is undoubtedly true that population growth implies a growing food demand, this demand need not be met by direct grain consumption. About 90 percent of U.S. grain consumption is by animals,

[2] U.S. Office of Technology Assessment, "Gasohol: A Technical Memorandum," Washington, D.C. (Sept. 1979).

and most of our grain exports (including soybeans) is consumed by animals. Very little of U.S. food exports helps to diminish world malnutrition, but instead helps put more meat on the tables of already adequately nourished peoples. Since alternative crops (such as sugarbeets) can be used both to ferment alcohol and to produce livestock feed nutrients, there need not be a diminished production of food in its final form (animal products) in conjunction with significant ethanol production. Also, it may be economically feasible to more fully utilize ocean biomass for both energy (methane) and food production (primarily protein) in the future. The study, in other words, takes such a narrow view of the food system (e.g., grain alone) that food and energy trade-offs appear to be inevitable, when in fact there does not need to be any trade-off if the food system is reorganized for greater total productivity (see CBNS–AEP 1, 5, and 6).

6. COST OF ETHANOL PRODUCTION

Three distortions appear in the report's analysis of cost. First, it is reported that the profitable price at the distillery of producing "gross" ethanol can be as low as $1.20 per gallon. But both the DOE Katzen study [1] and the OTA study [2] estimate a current selling price of around $1 per gallon. Second, the pie chart of ethanol manufacturing costs shown in Figure 1 of the report relegates the feed coproduct sales credit to a footnote, rather than subtracting its value (which is at least one-third the original grain cost) from the cost of the feedstock. Instead of $1.39 per gallon in manufacturing costs (before profit mark-up), the net cost of ethanol should be less than $1 per gallon (given the conversion costs shown in the pie chart). Third, the claim in the report, that the "true" price of "net" energy production is two or three times the "gross" price ($2.40–$3.60 per gallon) is based on a complete misapplication of marginal economic analysis, and flies in the face of well established, and rather rudimentary, principles of economics. This section of the report is amplified in a Science paper [3] co-authored by one of the committee members, Paul Weisz of Mobil Corporation. A critique of this analysis has been prepared by Richard Carlson [4] of CBNS.

APPENDIX II

THE TECHNICAL POTENTIAL FOR ALCOHOL FUELS FROM BIOMASS, JUNE 25, 1980

A. INTRODUCTION

In 1973, the Center for the Biology of Natural Systems began a five-year analysis (supported by the National Science Foundation) of ways to reduce the dependence of U.S. agriculture on petroleum-based imports.

Briefly stated, our research showed that, with appropriate changes in farm production patterns, fossil energy consumption in crop production could be cut by 60 percent. This reduction could be accomplished largely by eliminating use of indirect energy inputs (fertilizers and pesticides), with a small (11 percent) drop in yield but no drop in net economic returns per acre, since the decrease in input costs compensates for the loss in revenue (Lockeretz, et al, 1978).

In 1978, our research efforts turned to ways of reducing U.S. agriculture's dependence on direct petroleum inputs. At the outset, we assumed that with adoption of energy conserving farming practices and on-farm production of energy, farmers could at best, totally eliminate their own dependence on fossil energy inputs. We have since discovered that this assumption was too conservative. Indeed, our present research suggests a new concept: U.S. agriculture as a net producer of significant quantities of renewable liquid and gaseous fuels, without reducing the supply of food or livestock feed for domestic consumption or export.

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[1] Katzen, Raphael, and Associates, "Grain Motor Fuel Alcohol Technical and Economic Assessment Study," prepared for U.S. Department of Energy (June 1979) HCP/J6639–01.
[2] U.S. Office of Technology Assessment, "Gasohol: A Technical Memorandum," Washington, D.C. (Sept. 1979).
[3] Weisz, Paul B. and Marshall, John F., "High-Grade Fuels from Biomass Farming: Potentials and Constraints," Science, Vol. 206. Oct. 5, 1979, pp. 24–29.
[4] Carlson, Richard, A Response to Weisz and Marshall's "High Grade Fuels from Biomass Farming," Science (Oct. 5, 1979). (St. Louis: Center for the Biology of Natural Systems, Washington University, Jan. 16, 1979), CBNS–AEP–9.

Alterations in carbon to nitrogen ratio

We approached this idea by attempting to construct a cropping system, based largely on the land available in Midwestern agriculture, that would significantly increase the carbon content of the crop—beyond that needed, together with the crop nitrogen—to support the present output of livestock and grain for export (Carlson, et al, 1979).

Figure II compares the current crop system with an alternative system based on a rotation of corn, sugar beets and hay, that would considerably increase the potential for alcohol production. Thus, as shown in Figure II, the current crop system provides livestock with about 172 million tons of carbon and about eight million tons of nitrogen per year. In contrast, the alternative crop system developed in our study, based on a corn-sugar beet-hay rotation and the expansion of crop land by 10 percent, would yield about 267 million tons of carbon and about nine million tons of nitrogen per year (Commoner, 1979).

In the proposed scheme nearly all of the corn and sugar beet crop is fermented to produce ethanol. Since ethanol contains carbon, but no nitrogen, this process reduces the residual material to about 179 million tons of carbon per year, while the nitrogen content of the residue is maintained at nine million tons per year. Since the residue from alcohol fermentation ("distiller's dried grains and solubles") is an excellent nutrient for livestock production, the alternative scheme contains enough carbon and nitrogen constitutents to support as much livestock production as the current crop system.

The carbon to nitrogen ratio referred to in Table I is for the normally harvested portion of the plant, rather than its total biomass. Including the total biomass of the plant would increase its carbon to nitrogen ratio, but low disgestibility and palatability limit the use of agricultural residues for livestock feed.

Based on the equation for alcoholic fermentation,

$$C_6H_{12}O_6[\text{glucose}] = 2C_2H_5OH[\text{ethanol}] + 2CO_2[\text{carbon dioxide}]$$

two-thirds of the 95 million "excess" tons per year of carbon (i.e., that beyond the amount needed to support the present output of livestock) could be converted to ethanol by fermentation of the crop starch and sugar. As table II shows, this amounts to about 35 billion gallons of ethanol per year, or about one-third of the present U.S. gasoline consumption, based conservatively on the low crop yields of the 1974–76 period. (Corn, for example, averaged only 82 bushels per acre during those years, compared to subsequent years' yields of 100 bushels per acre.) Based on normal weather conditions and slightly improved yields in the future, grain and sugar crop yields would allow ethanol production to surpass 50 billion gallons per year by the year 2000, or nearly half of the present U.S. gasoline consumption.

Figure I shows significant disparities among several energy studies in their estimates of alcohol production potential between 1980 and the year 2000, based on use of grain surpluses and food processing wastes (category A), shifts of soybean acreage to corn production (category B), and shifts to sugar crops (category C). (Alcohol production from cellulose conversion, categories D and E, are discussed in a later section.) For 1980 and 1985, the relatively small differences between these studies are due largely to different assumptions about how much of the total biomass harvest goes into alcohol production. In 1990, the shift to sugar crops with dramatically increased carbon to nitrogen ratios causes the CBNS estimate to considerably outstrip the Office of Technology Assessment (OTA) estimate or the Energy Review Advisory Board (ERAB) estimate. The DOE Alcohols Fuels Policy Review estimate includes sugar crops at a minimal level. CBNS estimates of sugar based ethanol production in 2000 climb to 50 billion gallons per year based on sugar beet crops. OTA (seven to ten billion gallons) and ERAB (800 million gallons) continue to ignore sugar crops, and DOE (12 billion gallons) includes limited sugar crops based on sweet sorghum which yields ethanol, but less livestock feed per acre compared to sugar beets (Carlson, et al, 1980). Each of these three studies constrained the amount of alcohol that could be produced by assuming a tradeoff between food and fuel production.

Changes must be made in cropping patterns, in livestock feeding patterns and in the use of crop residues, if ethanol production is to be sharply increased. The

practical changes required to make these alterations are well within the demonstrated flexibility of the agricultural system.

Cropping patterns

The increase in soybean production after World War II is a particularly good example of the rate and extent of change possible in U.S. crop mixes. Between 1949 and 1969, more than 30 million acres of soybeans were brought into production. And in the last decade, another 15 million acres have been added, bringing the total harvested soybean acreage to about 65 million acres for 1979 (See Table III). The shift from corn to soybeans was important, because soybeans contain almost five times as much protein as corn.

A second example of changes in cropping patterns is the rapid growth in sunflower production. Stimulated by a demand for polyunsaturated oil, sunflower production has grown from less than one million acres to approximately five million acres in 1970s.

Ethanol production could be increased by replacing soybeans with corn and forage crops. There are virtually no agronomic barriers to substituting corn for soybeans. However, the yield of ethanol per acre from corn is considerably lower than from various sugar crops.

Sugar beets are an attractive alternative because of their relatively high yield of ethanol plus livestock feed coproducts per acre. Unlike other sugar crops (see Table IV) growing conditions appear to be favorable to sugar beet cultivation on essentially all land presently devoted to corn and soybeans, based on considerations such as precipitation (without requiring irrigation), temperature, and soil slope, composition, and pH (Roller, 1975). Pest problems (particularly with nematodes) can be avoided by rotating sugar beets (one year in four) with grain and forage crops (Johnson, et al, 1971). Since sugar beets have been grown on as many as 2.5 million acres, there would be very few problems with disseminating crop production knowledge.

Widespread changes in the U.S. crop mix will require a parallel increase in the availability of appropriate cultivation and processing equipment. The capacity of U.S. industry to keep pace with these changes is also illustrated by the soybean example. Few problems were encountered in supplying new planting and harvesting machines, as well as facilities for processing the soybeans.

Although concern has recently been expressed about the shortage of fermentation and distillation equipment, this is only a very short-term problem. It is generally recognized that a large-scale (e.g., 20–50 million gallons per year) ethanol production plant can be constructed within two to three years. On-farm units can be custom built in several months. And perhaps most significantly, factory assembled units suitable for on-farm and cooperative-scale application can be constructed by the thousands each year. For example, Solargizer International, Inc., of Bloomington, Minnesota, is contracting with Winnebago to build prefabricated alcohol plants capable of 500,000 gallons of anhydrous ethanol output per year. Thus, agriculture is flexible enough to make the necessary changes in the crop production system, and industry is likewise flexible enough to respond to the new demands of agriculture.

Livestock feeds

Livestock producers will be faced with significant changes in the composition of rations, if major shifts in the U.S. crop mix are accompanied by significant ethanol production. Past changes in livestock rations—from primarily range feeding, to use of more and more grain, and then to supplements of high protein soybean meal—demonstrate the flexibility of livestock feeding. The adjustments needed to achieve a new food plus fuel agricultural system represent even smaller magnitudes of change.

First, we have assumed that to achieve the same livestock output as the current U.S. feed system, any alternative must be capable of providing exactly the same level of major nutrients to both ruminants and non-ruminants. Specifically, the same output from fermentation coproducts of metabolizable energy and digestable protein (without increasing the intake of fiber or dry matter) is needed as is presently supplied from feed concentrates. This is a relatively conservative assumption since it appears that the fermentation process actually improves the value of certain crops by changes—such as increasing by-pass protein—which are not totally reflected in the absolute amount of major nutrients (Poos and Klopfenstein, 1979).

Second, the feeding of fermentation coproducts to livestock is already a well-established practice. The coproducts are typically fed to livestock either in the

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wet form, as whole stillage, or in the dried form, as distillers dried grains (five to ten percent solids) with forages to dairy and beef cattle is a common practice in parts of Kentucky, Tennessee and Virginia, where small beverage alcohol distilleries are in close proximity to farms (University of Tennessee Agricultural Extension Service). Feeding of DDGS is preferable because it greatly reduces the moisture intake of the livestock. The Distillers Feed Research Council has developed a wide array of alternative feed rations using DDGS derived from corn, for virtually all types of livestock.

In the livestock feed system proposed in our work, many more animals would be fed fermentation coproducts, but the percentage of coproducts in animal feed would be no larger than in generally accepted agricultural practice.

For example, Distillers Feed Research Council has dairy and beef rations in which corn DDGS amounts to as much as 30 percent of the total dry weight fed. In poultry rations, as much as 20 percent corn DDGS can be fed providing the proper lysine level is maintained. Even if as much as 50 billion gallons of ethanol are produced from agricultural crops and all of the fermantation coproducts are fed to domestic livestock, the levels specified above are not exceeded.

Critics of ethanol production such as Secretary of Agriculture Bob Berglund (1979) have noted DDGS cannot be fed to non-ruminants because of its relatively high fiber content. This problem can be avoided by separate production of distillers dried grain (DDG)—the fibrous portion of DDGS—and distillers dried solubles (DDS). DDS is very low in fiber and has been used successfully in non-ruminant livestock feed rations; the relatively higher fiber content of DDG does not present a problem in ruminant livetsock feed rations. Separate production of DDG and DDS is a common practice in large-scale ethanol production plants.

Thus, there appear to be no major barriers to increasing the number of livestock which receive fermentation coproducts as a part of their ration.

Crop residues and net energy

Crop residues play an important role in the implementation of the large-scale ethanol production system proposed in our research. In present farm practices, crop residues are left in the field primarily because of their value in reducing soil erosion. As ethanol production increases, we assume that crop residue will be valued as fuel for the conversion process for the following reasons:

(1) Crop residues are renewable and locally abundant and, therefore, are not prone to rapid price escalation or supply disruptions.

(2) Boilers fueled with crop residues require only minimal air pollution equipment for control of ash emissions; sulfur emissions are essentially zero.

(3) Equipment is now commercially available for collecting and directly combusting most every type of crop residue. As demand increases for this equipment, additional cost efficiency improvements can be expected.

(4) In addition to direct combustion boilers, crop residues can be converted to a low-Btu gas ("syngas", produced by pyrolysis) which can easily be used in standard natural gas or fuel oil boilers. Efficient gasification technology is rapidly approaching commercialization, even at the on-farm unit size.

(5) Farm practices such as planting of winter cover crops can be used to prevent increases in soil erosion which might be expected with higher removal rates of crop residues.

(6) Use of crop residues will ensure that the ethanol production process is a substantial net energy producer, by as much as 500 percent.

This last point is probably the most important and deserves additional explanation.

Until recently, critics of ethanol production have argued that ethanol production results in a large net loss of energy. For example, Peter Reilly (1978) of Iowa State University concluded that for each gallon of ethanol produced, 108,000 more Btu of energy are consumed than produced, resulting in a 56 percent net energy loss (see Figure III). Analyses such as these usually made at least one of three errors (Reilly made all three):

(1) Process energy requirements for fermentation and distillation were based on data from energy inefficient beverage alcohol plants, rather than modern facilities producing fuel-grade ethanol.

(2) The livestock feed coproduct was either ignored or credited on the basis of its combustable value, rather than its feeding value relative to the feedstock from which it was produced.

(3) The Btu value of ethanol was based only on its heat of combustion, thereby ignoring its value as an octane booster (yielding savings in gasoline refining) and

its overall superior performance as a transportation fuel with respect to miles per Btu.

As shown in Figure III, recent government studies no longer repeat all of the above errors and therefore have concluded that the net energy gain in ethanol production is at least zero to five percent (ERAB and AFPR), and possibly as high as 61 percent (OTA). The variations in these estimates stem primarily from the fact that DOE's Alcohol Fuels Policy Review (AFPR) and ERAB do not include a credit for ethanol beyond its heat of combustion, while OTA credits each gallon of ethanol with 41,120 Btu's for refinery savings in producing gasohol and 17,600 Btu's for improved miles per Btu in gasohol.

Most important is the fact that all three of these major studies conclude that ethanol production is a substantial net producer of energy (118 to 206 percent) when the conversion process uses a low quality solid fuel. By assuming the use of coal for processing heat, these studies calculate the net energy balance based only on high-grade fuels (liquids and natural gas) to arrive at gains exceeding 100 percent. In other words, the coal input is not included in the calculation because of its comparatively low quality.

Use of a low quality fuel in the processing plant is more rational than use of fuels such as fuel oil or natural gas. However, the principal fuel for generating process heat should be crop residues, not coal. Although coal may have several site specific applications, its use in general is undesirable because of its nonrenewability, the increasing cost of controlling emissions (particularly sulfur) and the uncertainty of supply for smaller users. And in the longer-term, the total social cost of using coal is undoubtedly higher than relying on renewable crop residues.

In contrast to the energy balances reported by ERAB, AFPR, and OTA, our research indicates that the net energy gain in ethanol production is actually closer to 500 percent (see Figure III). Our analysis differs from the three above in these ways:

(1) We assume as intensive a use of crop residues as can be expected without increasing soil erosion above present levels. Thus, on the energy input side of the balance we include with the crop cultivation energy and the energy required to harvest and transport residues. A small investment in residue collection yields a large amount of biomass available for boiler fuel. For example, one Btu spent on collection of corn stover yields enough biomass to provide about 50 Btu's of process heat.

(2) We calculate net energy gain using an incremental systems analysis: As a starting point, we determine the energy inputs to crop production destined for domestic livestock feed. We then calculate the additionel energy inputs reqiured for producing an alternative crop mix designed for ethanol and livestock feed production. Finally, net energy gain is stated as the ratio of energy output as ethanol (including refinery and fuel efficiency savings) to the incremental energy required for changing to a new slightly more energy-intensive crop mix designed for ethanol and livestock feed production. As the results show, a small investment in additional energy input can yield a large output of ethanol if the appropriate crop substitutions are allowed. (For additional information on this analysis, see Carlson, 1980).

Thus, as long as crop residues are the major fuel for conversion of biomass to ethanol, the net energy balance in ethanol production will be decidedly positive.

Cost of ethanol

Critics argue that although limited production of agricultural ethanol may be tolerated because of strong farmer interest in fuel self-sufficiency, total output should be limited to only a few billion gallons per year because other liquid fuels can be produced at a lower cost from abundant fossil resources such as coal, oil shale, and tar sands. As evidence, critics often point to the current wholesale price of ethanol -now about $1.65 per gallon, compared to wholesale gasoline at $.85 per gallon—and the extent to which ethanol is subsidized by the federal government and several states.

To determine whether ethanol from agriculture is cost-effective it is necessary to recognize the following points:

1. The current wholesale price of ethanol is substantially higher than its profitable manufacturing cost because of subsidies to gasohol retailers and the inability of producers to keep pace with demand. A state-of-the-art analysis by Raphael Katzen Associates (1979) indicates that ethanol can be produced profitably from corn at $2.30 per bushel for $0.89–1.16 per gallon in 1978 dollars. Because the ethanol industry is presently being subsidized—for whatever reason—the existing

price of ethanol is greater than its actual cost of production by the federal road tax rebate subsidy of $0.40 per gallon of ethanol, plus various state subsidies.

2. Without subsidization ethanol would cost slightly more than $1 per gallon according to most recent studies. Given that ethanol has only two-thirds the energy content of gasoline, critics charge that even if cost estimates are based on modern production techniques, ethanol is more expensive than $0.85 per gallon wholesale gasoline since the equivalent energy content of gasoline costs about $0.60 to produce. Here it must be noted that ethanol's market value stems not from its energy content, but from its ability to perform work—to propel vehicles—and its octane-enhancing characteristics when blended with gasoline. The precise data are still lacking to fully quantify these advantages. However, OTA has estimated, these two additional values may amount to $0.35–0.45 per gallon of ethanol, thereby increasing its competitive market value to around $1, or roughly equal to its cost of production.

3. In considering the long-run and dynamic consequences of alternative liquid fuel supply strategies, the cost of renewable alcohol fuel needs to be compared to the cost of synthetic fossil liquid fuels. As Figure IV shows, estimates made during the 1970s on the cost of ethanol produced from corn have been stable, even though more recent estimates account for air pollution control equipment, minimal waste water and energy conservation plant design. In the future, the cost of ethanol can be expected to remain fairly stable because new cost-reducing innovations are continually being developed. Since the construction time for ethanol facilities is four or five times shorter than for synthetic fuel plants, second or third generation ethanol design technology should more accurately be contrasted with the present synthetic fuel technology.

Since our estimate of how much alcohol fuel could be produced from biomass (both agriculture and forestry) without reducing food supplies is very large, this means that biomass feedstocks will remain constant in cost no matter how much alcohol is produced. In addition, some of the new technical innovations will allow more abundant and cheaper cellulosic feedstocks to be used.

The cost trend for methanol derived from coal, however, has been escalating exponentially over the same time period. As more environmental and worker health and safety protection measures are incorporated into the conversion plant's capital and operating costs, and as the price of coal rises, the price of methanol must also increase. In all likelihood, based on experience with the chemical industry, nuclear power, and other large complex technologies, capital and operating cost estimates can be expected to rise as oil and all other nonrenewable fuels rapidly increase in price.

4. Finally, after accounting for the long-run internalized private costs of competing liquid fuels, the remaining social damage costs of each alternative must be considered. For ethanol produced from crops or agricultural residues, the OTA and ERAB reports emphasize that serious environmental damage may result from energy farming.

First, they assume that more residue would be removed and row crop acreage expanded to marginal land, exposing the soil to the elements. Soil losses in the United States are large and increasing, according to the Soil and Conservation Service. Second, they assume that energy crop production would result in more intensive use of fertilizer and pesticides. This would consume more scarce petroleum in farming, as well as causing more pollution and health damage. Yet our analysis shows that ethanol production from agricultural crops need not involve expanding row crop land to marginal soils. What is required for ethanol production is a reorganization of cropping patterns on existing row crop land, replacement of row crops such as soybeans with high-carbon crops such as sugar beets, and the full use of fermentation feed coproducts in livestock rations.

This does not mean, however, that alcohol production cannot be expanded to marginal lands in environmentally benign ways. For example, interplanting of tree crops with pasture would allow for alcohol production without exposing the land to erosion; in fact, the presence of these trees would improve soil conservation. Also, forage crop-to-ethanol and methanol technologies are currently under development. Cultivation of forage crops from marginal lands does not present a problem of environmental deterioration.

It does not necessarily follow that no more crop residues could be removed from the land because soil erosion is a serious and worsening problem. First, changes in crop mix induced by ethanol production would probably result in

somewhat more residue production, allowing more to be harvested with the same amount left on the land.

Second, if more forage production is forthcoming from an increased carbohydrate price, hilly and marginal land can be better protected from soil erosion. Third, and most importantly, numerous studies have shown that conservation tillage practices (i.e., a primary tillage tool other than the moldboard plow) allow considerable residue removal while greatly reducing soil erosion from that of conventional land preparation. Conservation tillage need not also imply liquid fuel-saving minimum tillage, although this would be an added benefit (see, for example, Phillips, et al, 1980).

Since residue removal for providing distillery heat costs little in additional farming energy inputs (including additional inorganic fertilier energy), it offers a substantial payoff in renewable net energy gained by ethanol production.

Finally, contrary to the assertion by David Pimental in Lester R. Brown's (1980) Worldwatch paper No. 35, energy crops such as sugar beets need not result in any more fertilizer or pesticide pollution than crops such as corn or soybeans. Here too, the flexibility of agriculture comes into play, making it feasible to considerably reduce fertilizer and pesticide applications in U.S. field crop production without significant yield reductions. Such practices may, in fact, increase farm net income by reducing operating costs by as much or more than the crop revenue loss.

Although environmental damage costs to agriculture from energy farming can be easily alleviated, some of the potential environmental damages created by synthetic fossil fuels will be very expensive or impossible to control. For example, the damage to the world's climate from CO_2 build-up is a serious consequence of fossil fuel burning—especially synthetic fuels—but not of biomass fuels since the carbon released is quickly recycled into growing plants. The destruction of Western lands and the socio-economic consequences of boom towns are difficult to internalize into the private costs of synthetic fuels development.

C. EXTENSIONS OF THE FOOD-ENERGY INTEGRATION APPROACH

Detailed empirical evaluation of the food-energy system integration approach has been limited to considering only domestic livestock and feed crop production. Our present research also has not included a detailed exploration of the implications of advanced or second-generation alcohol conversion technology, and the entire problem of providing both food and alcohol to developing nations. In the sections that follow, we extend the basic scheme to use biomass to produce both food and energy to additional research areas including: other energy crops in the U.S., food and fuel from lignocellulosic sources, U.S. grain export substitution, and world agriculture.

Other energy crops in the United States

The geographical focus of biomass research at CBNS has been Midwestern U.S. agriculture, where the sugar beet appears to offer maximum potential presently to produce both ethanol and feed products. In the near future commercial varieties of fodder beet, a close relative of the sugar beet with up to 50 percent higher yield, or sugar beet-fodder beet hybrids may be used to increase productivity, (Earl and Brown, 1979). Another prospective energy crop for the Midwest region is white potato varieties which are too coarse for human consumption, but which yield twice as much biomass as conventional edible potatoes. Such yields would make the ethanol production per acre nearly equal for sugar beets and potatoes. Potatoes offer advantages over sugar beets because weed control is easier without herbicides, pest problems are generally less severe, full emergence is easier to achieve over a variety of weather conditions and the crop can be stored longer than sugar beets. Development of other energy crops, such as sweet sorghum, sweet sorghum-grain sorghum hybrids, or Jerusalem artichokes, for the Midwest could have the additional benefits of decreasing annual ethanol and feed output fluctuations because of adverse weather or pest conditions for a particular crop, and could alleviate the declining productivity associated with the present tendency towards monoculture.

For stoney, wet, or steeply sloped land in the Midwest, South and East, interplanting of tree crops which produce sugar pods, such as the honey locust, with forages for hay or pasture holds considerable promise in the near future (Santamour, 1978 and Zarger, 1956). Presently marginal row crop land, pasture

and hay land, and woodlots could be converted to this intercropping system. Forage yields may not decline significantly, and they could actually increase with proper grass species selection because of shade protection afforded by the trees during the hot, dry late summer season (Zarger and Lutz, 1961). On hilly land this crop system could virtually eliminate soil erosion on land currently devoted to row crops. Because so much land is presently in noncommercial forest and pasture, a very large aggregate ethanol and feed production potential exists for tree crops, even assuming modest yields per acre.

Food and fuel from lignocellulosic sources

While there is considerable disagreement over the desirability of using agricultural crops for alcohol fuel production, there appears to be general agreement that cellulose—from agricultural and forestry residues, and municipal solid waste—is a very attractive feedstock because of its abundance and apparent minimal interaction with the food-fiber-fuel system. Differences in analysis usually arise about the quantity of cellulose which can be removed from cropland without creating undue soil erosion or fertility problems, the cost of harvesting and transporting residues, and the determination of which alcohol conversion process is closer to commercialization: a biological or a thermochemical process.

According to DOE's "Report of the Alcohol Fuels Policy Review," by the year 2000 it may be possible to produce as much as 41.8 billion gallons of ethanol (3.3 quads), or 154.7 billion gallons of methanol (9.3 quads), from 549 million tons of wood and forestry residue, 278 million tons of argicultural residue, and 115 million tons of municipal solid waste. These quantities of alcohol fuels are substantial, but because the analysis fails to consider the principle of asking how food, fiber, and fuel production can be integrated, the following two interactive factors were not taken into account.

First, it must be recognized that yeast is an economically important coproduct of lignocellulose to ethanol conversion. Wolnak (1979) estimates that five percent of the sugar produced by cellulose hydrolysis is converted to recoverable yeast cells during fermentation, which amounts to 0.68 pound of dry yeast per gallon of anhydrous ethanol. Recycling of yeast to the fermentation process would reduce the recoverable yield, but this is not a widely accepted practice due to the increased risk of contamination. Given this conversion yield of glucose to yeast and DOE's estimate of ethanol production from cellulosic biomass, the production of yeast would be 14.2 million tons of 40 percent digestible protein feed. This amounts to 100 percent of the protein consumed by U.S. livestock in 1977 from soybean meal (USDA, 1978). Such a large input to the high-protein feed market could allow 22 million acres of cropland devoted to soybean production to be used for additional ethanol production from high-carbon energy crops, producing an extra nine to eleven billion gallons of ethanol. In turn, the feed coproducts of these energy crops would produce additional livestock feeds.

Seecond, it must aso be recognized that hemicellulose is a major constituent of lignocellulosic biomass, as shown in Table V. In the process of hydrolyzing cellulose to glucose (a six-carbon sugar), hemicellulose is broken down into pentoses (five-carbon sugars). According to a study by Arthur G. McKee Co. (1978) for DOE, 100 pounds of dry corn stover can yield 32 pounds of glucose and 45 pounds of pentoses. The glucose is converted to ethanol; the pentoses have two potential uses: (1) dried, they can be used as a high metabolizable energy livestock feed; or (2) using a bacterial fermentation process, about 129 gallons of butanediol can be produced per ton of pentoses. Butanediol is a four-carbon alcohol which mixes more easily with gasoline than methanol or ethanol, and it has a heat of combustion which is intermediate between ethanol and gasoline. Thus, for every gallon of ethanol produced from corn stover, a coproduct of about 20 pounds of livestock feed or 1.3 gallons of butanediol can also be produced. Similar yields can be expected from other types of lignocellulosic biomass.

Figure I shows that OTA, AFPR and ERAB include estimates in their analysis of ethanol production from cellulose (category D), but all fail to consider the potential for butanediol production from hemicellulose. Addition of this factor in the CBNS analysis more than doubles the total alcohol output from the same lignocellulosic biomass resource base.

Thus, recent reports on energy production from cellulose which prefer the methanol process over the ethanol process on the basis of almost three times greater energy output from the thermochemical methanol route have failed to

consided the yield potential for yeast, and for either additional livestock feed (pentoses) or alcohol (butanediol) from the biological process. The assumed independence of food and fuel production when using cellulose biomass as the feed stock does not necessarily exist.

U.S. grain export substitution

The calculations presented in section B assumed that cropping changes were made only on cropland currently devoted to domestic livestock feed production. Production of all grains and soybeans for export was assumed to remain unchanged. However, additional potential for alcohol production is possible if our original constraint is changed to one of maintaining the same level of nutrients for export. The following considerations illuminate this potential:

About one-fourth of total harvested cropland is devoted to production of the three major U.S. export crops—corn, soybeans and soybean meal, and wheat, which are produced roughly in the proportions 2:1:1 by weight (USDA–FAS, 1980). Virtually all of the exported corn and soybeans are used for feeding livestock in other developed nations. Wheat is used mainly for direct human consumption, but a surprisingly large amount—20 percent—of total world production in 1978–1979 was fed to livestock (USDA–FAS, 1980). Given that about three-fourths of our total grain crop exports end up as livestock feed, appropriate change in U.S. export crop production patterns could yield additional ethanol for domestic consumption plus livestock feed coproducts for export containing equivalent levels of metabolizable energy and protein to existing exports. Once again, we can see the potential for ethanol production without interfering with livestock feed production so long as we are willing to consider the flexibility of the U.S. agricultural system to adopt new practices based on integration of food and fuel production.

Even with U.S. exports earmarked for direct human consumption (a large proportion of which goes to Japan and other developed countries), some potential for fuel and food coproduction may exist. In a modern "biomass refinery" ethanol plant, high-protein (60 percent) gluten meal can be separated from the starchy portion of the grain prior to fermentation. The gluten meal can then be used as a nutritional supplement in a wide variety of prepared foods, and the starch can be used in ethanol production. Such separation processes also yield an edible oil, and an oil cake suitable for livestock feed (Process Engineering Company, 1980). However, a limiting factor on direct food coproduct production is that high income people prefer to eat protein in animal product form, while the world's poor cannot afford to pay for processed foods incorporating high-protein vegetable supplements.

International agriculture

Many people share a valid humanitarian concern over the consequences for world food production of a substantial program to use agricultural crops for energy, in the United States or elsewhere. This "food versus fuel" viewpoint was forcefully expressed recently by Lester R. Brown (1980): "Production of fuel from food crops will permit the affluent of the world to continue driving cars while the less developed countries pay higher and higher prices for food." However, it cannot be simply concluded without a close technical and economic investigation that consuming agricultural crops for production of fuel ethanol will necessarily result in less food availability for the poor. After several distorted or omitted points in Brown's analysis are clarified, the outlook appears much more optimistic.

First, Brown claims that hunger, soil erosion, deforestation and desertification are all evidence of global shortage of food production resources. While these conditions are evidence of maldistribution of income and misallocation of resources in specific countries, they cannot be taken as evidence of global agricultural resource scarcity. Indeed, the numerous studies of world agricultural resources arrive at the same conclusion: world physical resource capacity is sufficient to produce several times more grain than is likely to be demanded through the year 2000 (Clark, 1970; Buringh, et al., 1975; Revelle, 1976; Chou, et al. 1977; Rojko, et al., 1978). This amount is adequate for even the most pessimistic of the U.N. population scenarios, stability at 16 billion in 2135. In contrast, Lester Brown (1974) has argued that equilibrium at 6 billion is achievable.

Second, Brown claims that increases in food imports are evidence that a country's nutritional level has deteriorated. However, rising food imports are not necessarily a signal that a country is less able to feed its people. The fact that a country can afford to increase its food imports is generally evidence that incomes and nutritional standards are improving. The most obvious example is Japan, the largest importer of U.S. grain. More recent examples are our most rapidly growing food export markets: Korea, Taiwan and mainland China. Increases in food imports, especially since the demise of PL–480 concessional sales, are just as likely to be a sign of economic progress than an omen of future scarcity for the importing country.

The success of Japan, Korea, Taiwan and China in feeding their people suggests the third point ignored by Brown's analysis: the world food problem is not a production problem but an employment problem. Among the developing countries these have been outstanding in providing productive employment to the majority of the population. This has been accomplished through successful land reforms, the promotion of labor-intensive agricultural techniques, and massive investment in the agricultural sector. Given access to productive resources—land, roads, irrigation, projects, agricultural extension services, etc.—new farmers can decide whether to directly produce food or to produce cash crops to pay for their food purchases. With income to make their food demand effective in the market place, the employed bid up the price of food which in turn makes investment in the agricultural sector more attractive. Land does not get developed simply because people are hungry. Hunger must be accompanied by economic or political power to bring about the necessary investment. In the absence of political or economic power, a condition that characterizes the world's hungry, an alternative path is through the development of energy crops.

The tremendous effective demand of the world's automobile owners for gasoline could begin to induce the use of land, labor and other resources to develop the agricultural infrastructure in the world's land surplus countries rather than generating OPEC and oil company profits. This development process could open up massive new areas of cropland and improve the yields of existing cropland, with the potential to employ millions of those presently nutritionally deficient, and to provide them with resources to produce both food and fuel.

TABLE I.—CARBON AND NITROGEN BALANCE

Crop	Carbon (10^6 tons)	Nitrogen (10^6 tons)	C/N
Current system:			
Soybean meal	4.4	1.9	2.3
Grain	38.8	1.6	24.3
Silage	16.0	.5	33.3
Hay	49.2	2.7	18.2
Pasture	63.9	1.4	46.5
Total	172.3	8.1	21.3
Alternative system prior to fermentation:			
Grain	69.8	2.9	24.3
Sugar beet, roots	68.5	1.9	36.6
Corn cobs	15.7	.17	93.0
Hay	49.2	2.7	18.2
Pasture	63.9	1.4	46.5
Total	267.1	9.1	29.5
Alternative system after fermentation:			
Grain stillage	19.2	2.9	6.9
Beet stillage	12.8	1.1	11.6
Beet pulp	18.0	.8	21.9
Corn cobs	15.7	.17	93.0
Hay	49.2	2.7	18.2
Pasture	63.9	1.4	46.5
Total	178.8	9.1	19.7

Source: National Academy of Sciences, "Atlas of National Data on United States and Canadian Feeds (1972)." Percent carbon calculated on the basis of nitrogen-free extract, ether extract, and crude fiber; percent nitrogen calculated from crude protein.

TABLE II.—LIVESTOCK NUTRIENT PRODUCTION

Livestock feed	Land (10^6A)	Dry matter (10^6T)	Digestible protein (10^6T)	Total digestible nutrients (10^6T)	Ethanol (10^9 gal)
Current food system:					
Soybeans	21	23	10.7	19.9	
Grain	76	95	8.8	103.5	
Silage	14	38	1.7	26.4	
Hay	61	123	12.9	73.8	
Pasture	84	148	13.8	100.2	
Total	262	427	46.2	323.8	
An example food and fuel system:					
Beet stillage	40	36	4.0	27.3	16.2
Beet pulp		44	2.0	33.1	
Grain stillage	115	59	15.8	64.6	18.8
Corn cobs		34	0	17.1	
Hay	61	123	12.9	73.8	
Pasture	84	148	13.8	100.2	
Total	300	444	48.5	316.1	35.0

Sources: U.S. average crop yields and livestock feed consumption from cropland (excludes range and permanent pasture) for 1974–76 (years of low grain yields) in USDA, "Agricultural Statistics, 1977." Digestible nutrients of feeds from Frank B. Morrison, "Feeds and Feeding," 22d ed. (Clinton, Iowa: Morrison Publishing Co., 1959).

TABLE III.—U.S. HARVESTED ACREAGE OF CORN AND SOYBEANS, 1924–78

Year	Corn (10^6A)	Soybeans (10^6A)
1924	100.4	0.4
1929	97.8	.7
1934	92.2	1.6
1939	88.3	4.3
1944	94.0	10.2
1949	85.6	10.5
1954	80.2	17.0
1959	81.9	22.6
1964	65.4	30.8
1969	63.2	40.9
1974	76.7	52.4
1978 [1]	75.1	63.3

[1] Estimated.

Sources: USDA, "Agricultural Statistics, 1978" for 1924–74. USDA, "Agricultural Outlook" (September 1978) for 1978.

TABLE IV.—REPRESENTATIVE ETHANOL AND STILLAGE YIELDS FOR SELECTED FEEDSTOCK CROPS [1]

Feedstock crops	Ethanol (anhydrous gallons)		Stillage (dry matter)	
	Per fresh weight ton	Average per acre	Pounds per fresh weight ton	Average tons per acre [2]
Sugar crops:				
Sugar beets [3]	22	420	100	1.00(3.95)
Sweet (sugar) sorghum [4]	15	280	220	2.05
Sweet (syrup) sorghum [4]	13	340	240	3.14
Sugarcane [3]	15	623	200	4.00
Jerusalem artichokes [5] (branching tuber)	21	480	100	1.14(4.68)
Fodder beets [6]	18	950	115	3.03(?)
Starch crops:				
Corn [7]	93	225	580	.70
Sorghum [7]	93	135	540	.39
Wheat [7]	93	95	620	.33
Potatoes [3]	23	280	76	.46
Sweet potatoes [3]	34	190	92	.26

[1] These data are to be regarded as approximations only; significant variations can be expected depending on the feedstock composition, the efficiency of conversion and recovery of products, and crop yields. For the starch crops, the yield data are generally based on practical experience, usually of the beverage alcohol industry. For the sugar crops, the yield data, as cited in the recent literature (see sources listed below) are typically calculated from the crops' fermentable sugar content, since very few fermentation tests have been done as yet with these crops.

[2] Numbers in parentheses also indicate the additional yields of crop dry matter (e.g., sugar beet tops) which can be used for livestock feed, but is not directly involved in the ethanol conversion process.

[3] Portola Institute. "Energy Primer." Friche-Parks Press, Inc., Fremont, Calif. (1974).

[4] Nathan, R. A. "Fuels from Sugar Crops," DOE Critical Review Series. NTIS No. TID-22781 (1978).

[5] Stauffer, M. D., et al. "Jerusalem Artichoke." Agriculture Canada, CDA Research Station (March 1975).

[6] Earl, W. B., and Brown, W. A. N. "Alcohol Fuels from Biomass in New Zealand—The Energetics and Economics of Production and Processing," Alcohol Fuels Technology Third International Symposium, pp. 1–12, Asilomas, Calif. (May 28–31, 1979).

[7] Solar Energy Research Institute. "Fuel from Farms—A Guide to Small-Scale Ethanol Production," SERI, Golden, Colo. (1979).

TABLE V.—TYPICAL COMPOSITION OF CELLULOSIC RESIDUES[1]

[Percent]

	Corn residue[2]	Tall fescue[3]	Softwood
Cellulose	38	34	42
Hemicellulose	26	25	25
Lignin	11	8	28
Other[4]	25	32	5

[1] Source: Ladisch, M. R. "Fermentable Sugars from Cellulosic Residues." Process Biochemistry: 21–25 (January 1979).
[2] Harvested in late October; cellulose and hemicellulose content are higher in residue harvested earlier; content varies from year to year.
[3] Harvested at feeding stage.
[4] In crop residues this includes proteins, minerals, and soluble sugars.

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Senator McGovern. Thank you very much, Mr. Commoner, for your excellent statement. We will come back to questions later on. I did want to make just one observation apropos of what you said about the very low estimate that we have from ERAB as to how much alcohol-based fuel we can produce.

At the December 10 gasohol study group meeting the chairman, Mr. Pimentel, stated a likely alcohol target of 200 to 300 million gallons by 1985. I visted the Archer Daniels Midland plant at Decatur, Ill., where they already have the capacity of 100 million gallons in that one plant, and they tell me that by the end of 1981 they will have two additional plants that will bring the production of that one company up to 250 million gallons. That's just one single company and I know the officers of that company—the president, Mr. Andres, is a superb businessman, and I have no doubt that they are going to meet those estimates.

So there you have a single company achieving the target that Mr. Pimentel sets for the entire Nation.

Mr. COMMONER. There's a similar size plant going up in the Northwest right now. It's an absurdly low estimate. I don't know where they got it.

Senator MCGOVERN. We'll come back to those points and others later. I'd like to move on now to Mr. William Scheller, who's a professor of chemical engineering at the University of Nebraska, and Professor Scheller was also a member of the gasohol study group. So, Professor Scheller, we will be glad to hear your statement.

STATEMENT OF WILLIAM A. SCHELLER, PROFESSOR, DEPARTMENT OF CHEMICAL ENGINEERING, UNIVERSITY OF NEBRASKA

Mr. SCHELLER. Senator McGovern, thank you for the opportunity of being at this hearing today. I have submitted a complete prepared statement. Because of the time limitation, I would like to summarize three major points in my statement.

The first of these points deals with the energy balance for gasohol production and use. The ERAB gasohol report states:

> Using either existing technology or the best available technology before 1985 with existing oil or gas fueled fermentation/distillation plants, the net energy return for ethanol production from corn and other crops is about zero.

Table 1 on page 24 of the ERAB report shows an energy loss for ethanol production because of an unwillingness to include all realistic energy relationships for certain products such as the distillers dark grains—that is the byproduct of cattle feed. The distillers dark grains from 1 bushel of corn can replace 1 bushel of corn in a calf or cattle raising operation up to at least 20 percent of the corn ration and it can displace other protein sources in the ration based on an equivalent protein basis. This is interpreted to mean that the equivalent energy value of the distillers dark grains from 1 bushel of corn is equal to the energy required to produce 1 bushel of corn. A second basis of comparison is in terms of the digestible energy of the distillers dark grains which is almost equal to the energy required to produce 1 bushel of corn.

The ERAB report gives an energy value to the distillers dark grains of only about 25 percent of the energy required to produce the corn. On this one energy quantity alone hangs the reason for their negative energy balance. If the correct value of 45,000 Btu's is used in the ERAB report table 1, page 24, we find an energy gain of 18,000 Btu's instead of their indicated loss of 16,000 Btu's. This gain is realized even if the plant is fueled with oil or natural gas.

Furthermore, the ERAB report does not give appropriate credit to the refinery energy savings resulting from the high octane of grain alcohol nor does it seriously consider the fact that there are synergistic effects which result in improved fuel economy with gasohol. These matters are described in quantitative detail in appendix I of this testimony. In total, if the distillery is fueled with oil or with natural gas, there is a net energy saving of 184,500 Btu's per gallon of grain alcohol used in the production of gasohol. This is equivalent to a saving of 1.23 gallons of crude oil for each gallon of alcohol.

The second point I would like to comment on is the cost of grain alcohol production. The ERAB report states on page 5:

> The cost of corn constitutes 73 percent of the manufacturing cost of ethanol; hence, process research directed to other areas of cost reduction will have little impact.

This statement is very misleading to the uninformed because it does not mention that there is a high byproduct credit for the distillers dark grains which can be applied against the cost of the grain. Furthermore, as the cost of grain increases the value of the byproduct also increases and tends to stabilize the net raw material cost for the grain alcohol. A second byproduct, carbon dioxide, if recovered and sold, can reduce the net raw material cost even further.

In the first draft, December 13, 1979, of the ERAB report, Mr. Pimentel included the byproduct credit in his graphical representation of the grain alcohol costs, but in the December 20, 1979, report and the February 22, 1980, revision this figure 1, page 28, no longer contains the byproduct credit as part of the graph but relegates it to a footnote. The cost of grain alcohol production based on a 20-million-gallon-per-year plant is contained in the complete written testimony. In this cost breakdown the net grain cost is 42 percent of the alcohol cost.

There is an opportunity to reduce costs in the areas of utilities and labor through more effective energy utilization or lower cost fuels and increased automation in the plant. A lower capital investment will result in lower property taxes and insurance, lower depreciation, and possibly lower maintenance. Process improvements can also result in reduced yeast, enzyme, and chemicals use.

The third point I'd like to cover briefly is the comparison of methanol and ethanol production.

The ERAB report which was stated by Mr. Pimentel before the meeting to be a report on the "Benefits of Gasohol Production" became in its final form an advocate of methanol production from coal without presenting to the reader the many environmental problems accompanying this product. In fact, only two sentences are devoted to the environmental problems of methanol production from coal, while a total of almost three pages of environmental problems, many in my opinion unfounded, were discussed for grain alcohol.

In the report recommendations no mention of environmental problems was made when recommending methanol production. Mr. Pimentel states that the process efficiency of the production of methanol from coal is 50 percent yet in very detailed studies of the same process Bechtel Corp., a large engineering firm that has carefully analyzed the process for DOE, finds the thermal efficiency of the process to be 38 percent. Bechtel finds the capital investment for a very large methanol plant to be about $2 per gallon of annual capacity, about the same as an ethanol plant of only 1.4 percent of the capacity. This says that even large ethanol plants will be less expensive per annual gallon of capacity than very large methanol plants. Let us return to the matter of thermal efficiency. One bushel of corn contains 34 pounds of starch which when fermented will yield 2.6 gallons of anhydrous ethanol. If 34 pounds of Wyoming coal are converted into methanol

at a 38 percent efficiency, 1.6 gallons of methanol will result. The energy content of the 2.6 gallons of ethanol is 219,400 Btu's while the energy content of the 1.6 gallons of methanol is only 103,400 Btu's.

The ERAB report says that methanol production technology from coal is commercially available now and is capable of producing methanol on a large scale. The fact is that actually no such large scale plants are in operation. You cannot order such a plant the way a large fermentation plant for producing ethanol from grain can be ordered. We are still many years away from the commercial large scale production of methanol from coal in reliable debugged plants.

My comments should not be construed as being "anti-methanol." Our great Nation is going to need all of the domestic liquid fuel that we can produce if we are to achieve energy independence, but I do not want to see a viable fuel, ethanol, that is fully capable of being placed in the marketplace now pushed aside by the promises of certain organizations with vested interests that they have a better fuel, methanol, that is all ready to be produced for the marketplace.

Thank you, Senator.

[The prepared statement of Mr. Scheller follows:]

PREPARED STATEMENT OF WILLIAM A. SCHELLER

I. PERSONAL BACKGROUND

My name is William A. Scheller and my profession is Chemical Engineering. I received my B.S. and Ph.D. degrees in this discipline from Northwestern University and spent eight years with the wholly owned subsidiary of Standard Oil Company of California, California Research Corporation (now Chevron Research) in the areas of petroleum and petrochemical process design, process engineering and engineering research. In 1963 I left to join the faculty of Chemical Engineering at the University of Nebraska where I presently hold the academic rank of Professor of Chemical Engineering. From 1971 to 1978 I served as Chairman of the Department and as a member of the Executive Committee of the College of Engineering. I am a Fellow of the Graduate Faculty and former member of the Graduate Council. As provided for in the bylaws of the University and as encouraged by the College of Engineering I have in the past and I continue to consult in my areas of expertise including petrochemical processes, petroleum refining, steel production, grain alcohol production, chemicals and fuels from biomass, process economics, process energetics and solution thermodynamics.

In 1971 the Nebraska Legislature passed LB-776 which established the Agricultural Products Industrial Utilization Committee and the grain alcohol fuels program in Nebraska. I was asked by the committee and the University in 1971 to be technical adviser to the committee and I continue to hold that position today. I originated the name GASOHOL in 1972 at one of the committee meetings. I am a director of the National Gasohol Commission and have written over 25 papers on alcohol production, economics, processes, fuels and energetics since 1973. I designed and directed the Nebraska two million mile Gasohol road test program. My work in the field of ethanol and alcohol fuels has been read, recognized and accepted throughout the world.

II. INTRODUCTION

On November 16, 1979 I received a phone call from Mr. Robert Weinraub of the U.S. Department of Energy inviting me to serve as a member of a Gasohol study group to assist in the preparation of a report of Gasohol by ERAB. I accepted the invitation. A meeting of the study group was held in Washington, D.C. on December 10 and 11, 1979 and I attended. This is the only meeting of this study group that I know of. Prior to this meeting Dr. David Pimentel, Chairman of the Gasohol Study Group and a member of ERAB contacted Dr. Richard L. Hinman of Pfizer, Inc. also an ERAB member and Study Group member and ask him to prepare a short report on energy and economic aspects

of ethanol production from grain. Dr. Pimentel also asked Dr. Sandy Harris then of D.O.E. to prepare a similar report on energy and economic aspects of methanol production from coal. Dr. Pimentel said that he would prepare a short report on the impact of Gasohol production on agriculture, land and the environment. These reports were handed out to the Study Group on the first day of the meeting. Dr. Pimentel wrote the Study Group members that in the meeting we would be drafting a brief report on the "Benefits of Gasohol Production".

At the beginning of the meeting on December 10, 1979 I handed out ten copies of a report entitled "Gasohol, Ethanol and Energy" which I had presented at the National Gasohol Commission Meeting in San Antonio, Texas a few days earlier. A copy of this report is attached to this testimony as Appendix I. The attached copy contains an appendix beginning on page 13 which was added after the copies of the report were given to the Study Group. At the same time Dr. Paul B. Weisz of Mobil Oil Research and Development Corporation submitted a report entitled "Net Fuel Productivity Of Grain Alcohol Fuel Production" dated October 18, 1979. My report was not included in the references cited in the ERAB Gasohol report even though the energy balance information contained in the report was discussed at length in the Study Group meeting. When I referred to this report in a phone conversation with Dr. Pimentel he said he could not find it in his file on the meeting even though I saw him put a copy in his file at the Study Group meeting on December 10, 1979. An outdated paper of mine from 1976 was referenced in the ERAB report.

Dr. Pimentel had the first draft of the 31 page report entitled "Gasohol Study" completed two days after the end of the Study Group meeting on December 11, 1979. He sent a copy to me via Federal Express on December 14, 1979. I gave my comments to him by phone and on December 20, 1979 he sent to Dr. Solomon J. Buchsbaum, ERAB Chairman the final copy of the report. As a result of further objections to this "final" report further comments were received and a final revised copy dated February 22, 1980 was transmitted by Dr. Pimentel. All of my comments on the various copies of the report were given to Dr. Pimentel by phone. They were not for the most part incorporated into the final report. Following are my views of the energy balance related to grain alcohol and to gasohol, the cost of grain alcohol production and the comparison of methanol with ethanol.

III. ENERGY BALANCE FOR GASOHOL

The ERAB Gasohol report states "Using either existing technology or the best available technology before 1985 with existing oil or gas fueled fermentation/distillation plants, the net energy return for ethanol production from corn and other crops is about zero. If fermentation/distillery plants were fueled by coal then each gallon of ethanol produced could save roughly 0.5 gallons of oil." The energy balance is much more favorable than this.

Table 1 on page 24 of the ERAB report show an energy loss for ethanol production because of an unwillingness to include all realistic energy relationships for certain products such as the distillers dark grain (byproduct cattle feed). The distillers dark grains from one bushel of corn can replace one bushel of corn in a calf or cattle raising operation up to at least 20% of the corn ration and it can displace other protein sources in the ration based on an equivalent protein basis. This is interpreted to mean that the equivalent energy value of the distillers dark grains from one bushel of corn is equal to the energy required to produce one bushel of corn. A second basis of comparison is in terms of the digestible energy of the distillers dark grains which is almost equal to (96 percent) of the energy required to produce one bushel of corn. The ERAB report gives an energy value to the distillers dark grains of only about 25 percent of the energy required to produce the corn. On this one energy quantity alone hangs the reason for their negative energy balance. If the correct value of 45,000 Btu's is used in the ERAB report Table 1, page 24 we find an energy gain of 18,000 Btu's instead of their indicated loss of 16,000 Btu's. This gain is realized even if the plant is fueled with oil or natural gas.

Furthermore the ERAB report does not give appropriate credit to the refinery energy savings resulting from the high octane of grain alcohol nor does it seriously consider the fact that there are synergistic effects which result in improved fuel economy with gasohol. These matters are described in quantitative detail in Appendix I of this testimony and especially in pages 8–13 of the Appendix. In total if the distillery is fueled with oil or with natural gas there

is a net energy saving of 184,500 Btu's per gallon of grain alcohol used in the production of gasohol. This is equivalent to a saving of 1.23 gallons of crude oil.

IV. COST OF GRAIN ALCOHOL PRODUCTION

The ERAB report states on page 5 "The cost of corn constitutes 73 percent of the manufacturing cost of ethanol; hence, process research directed to other areas of cost reduction will have little impact." This statement is very misleading to the uninformed because it does not mention that there is a high byproduct credit for the distillers dark grains which can be if applied against the cost of the grain. Furthermore as the cost of grain increases the value of the byproduct also increases and tends to stabilize the net raw material cost for the grain alcohol. A second byproduct, carbon dioxide, if recovered and sold can reduce the net raw material cost even further. In the first draft (Dec. 13, 1979) of the ERAB report Dr. Pimentel included the byproduct credit in his graphical representation of the grain alcohol costs (Figure 1, page 27) but in the December 20, 1979 report and the February 22, 1980 revision this Figure 1 (page 28) no longer contains the byproduct credit as part of the graph but relegates it to a footnote. The cost of grain alcohol production in a 20 million gallon per year plant is:

Item	Cost per gallon of EtOH	Percent
Corn at $2.50 per bushel	95.8	
Less DDG at $130 per ton	(45.1)	
Net grain cost	50.7	41.7
Utilities cost	13.2	10.9
Labor, includes benefits	7.5	6.2
Maintenance	5.6	4.6
Property taxes and insurance	4.3	3.5
Yeast, enzymes, and chemicals	6.0	4.9
Depreciation (10 percent straight line)	17.0	14.0
Corporation taxes (50 percent)	17.2	14.2
Grain alcohol cost	122.9	100.0

Thus we see that out of the cost of producing grain alcohol there is an opportunity to reduce costs in the areas of utilities and labor through more effective energy utilization or lower cost fuels and increased automation in the plant. A lower capital investment will result in lower property taxes and insurance, lower depreciation and possible lower maintenance. Process improvements can also result in reduced yeast, enzyme and chemical use. The above list of items which might be improved upon amounts to 55 cents per gallon of alcohol which is more than the net grain cost. I do not agree with the ERAB report statement that process research will have little impact. A dime saved is a dime earned and with a 50 percent tax rate is another five cents of profit. Saving 6 cents on the manufacturing cost will increase the profit after taxes by about 17 percent.

A further method for reducing the cost of grain alcohol manufacture is to increase the value of the byproduct credit. At Nebraska we have designed and demonstrated on a bench scale a process for extending proteins suitable for human consumption from distillers dark grains. The interesting fact about this process is that the proteins that are extracted are the proteins which have the greatest use for humans and the least use to the cattle. In the cattle feed their protein value can be replaced by adding an inexpensive chemical called urea. On the other hand the proteins that remain in the distillers dark grains are insoluble proteins or bypass proteins which are of little value to humans but of great value to the cattle. Protein recovery has the potential of lowering the above manufacturing cost to less than 95 cents per gallon.

V. COMPARISON OF METHANOL AND ETHANOL PRODUCTION

The ERAB report which was stated by Dr. Pimentel before the meeting to be a report on the "Benefits of Gasohol Production" became in its final form an advocate of menthanol production from coal without presenting to the reader the many environmental problems accompanying this product. In fact only two sentences are devoted to the environmental problems of methanol production from

coal while a total of almost three pages of environmental problems (many in my opinion unfounded) were discussed for grain alcohol. In the report recommendations (pages 11–12) no mention of environmental problems was made when demonstrated on a bench scale a proces for extending proteins suitable for human recommending methanol production. Dr. Pimentel states that the process efficiency of the production of methanol from coal is 50 percent yet in very detailed studies of the same process Bechtel Corporation a large engineering firm that has carefully analyzed the process for D.O.E. finds the thermal efficiency of the process to be 38 percent. Bechtel finds the capital investment for a very large methanol plant to be about $2 per gallon of annual capacity, about the same as an ethanol plant of only 1.4 percent of the capacity. This says that even large ethanol plants will be less expensive per annual gallon of capacity than very large methanol plants. Let us return to the matter of thermal efficiency. One bushel of corn contains 34 pounds of starch which when fermented will yield 2.6 gallons of anhydrous ethanol. If 34 pounds of Wyoming coal are converted into methanol at a 38 percent efficiency 1.6 gallons of methanol will result. The energy content of the 2.6 gallons of ethanol is 219,400 Btu's while the energy content of the 1.6 gallons of methanol is only 103,400 Btu's.

The ERAB report says that methanol production technology from coal is commercially available now and is capable of producing methanol on a large scale. The fact is that actually no such large scale plants are in operation. You cannot order such a plant the way a large fermentation plant for producing ethanol from grain can be ordered. We are still many years away from the commercial large scale production of methanol from coal in reliable debugged plants.

My comments should not be construed as being "anti-methanol". Our great nation is going to need all of the domestic liquid fuel that we can produce if we are to achieve energy independence but I do not want to see a viable fuel (ethanol) that is fully capable of being placed in the market place now pushed aside by the promises of certain organizations with vested interests that they have a better fuel (methanol) that is all ready to be produced for the market place.

Mobil Oil Company was represented on the Gasohol Study Group by Dr. Paul B. Weisz and Mobil has been very actively promoting a process which they have developed for converting methanol to gasoline. Dr. Weisz has published many papers that are negative toward ethanol but positive toward methanol and the Mobile-M process for converting methanol to gasoline. On March 24, 1980 the Wall Street Journal reported that D.O.E. had provided Mobil with partial funding to build a pilot plant for the Mobile-M process in Germany. On April 2, 1980 the same newspaper reported that Mobil had sold a Mobile-M plant in New Zealand for $380 million. Some people have questioned why a commercial process is receiving development funds from D.O.E. Furthermore on March 25, 1980 an Associated Press news story reported that Mobil will build a $2 billion petrochemical complex in Saudi Arabia and this will be located at the same site as their $1 billion oil refinery.

I am further concerned about the fact that in Saudi Arabia there are presently 2.2 million gallons per day of methanol capacity under construction using gases from their refineries that are currently being flared. This methanol can be very cheap since it is made from waste gas and could be exported to the U.S. at prices that would make methanol from coal unattractive. Mobil enjoys a very special position with the Saudi royal family because of certain favors they did for a family member during a time of crisis. It is conceivable that the Saudis might take marketing steps to assure the success of the Mobile-M process. Perhaps the planning for the introduction of methanol into the U.S. fuel market has been under way for a number of years. On May 8, 1974 the Wall Street Journal printed a short article noting that the House of Representatives had eliminated the 7.6 cent per gallon duty on methanol imported into the U.S. for use as fuel. Copies of all of the news items that I refer to here are included in Appendix II.

VI. CONCLUSION

In conclusion I wish to say that in my opinion the ERAB Gasohol report is not wholly objective. We should move full speed ahead with the nation's Gasohol program and not let it be side-tracked by promises of plentiful and cheap methanol from coal now. On the other hand development of the production of methanol should be continued but we should be certain the interests of the U.S. are protected in this area. Methanol developments in Saudi Arabia and other mid-

eastern countries should be monitored carefully and the activities of international oil companies with their home offices in the United States should be followed in detail to assure that we are not made even more dependent on foreign energy through the import of methanol and ethanol. The Congress should restore the duty on methanol imported for fuel.

APPENDIX I

GASOHOL, ETHANOL AND ENERGY

(By Dr. Wm. A. Scheller, University of Nebraska, Lincoln, Nebr., presented at the National Gasohol Commission Meeting, San Antonio, Tex., December 2–5, 1979)

INTRODUCTION

The question of energy utilization and energy efficiency in the Gasohol program has generated much discussion and considerable controversy. The purpose of this paper is to present a detailed energy balance associated with the components of the Gasohol program, i.e., grain production, fuel alcohol production and the replacement of gasoline with ethanol to produce Gasohol. The overall energy balance involves a comparison of a Gasohol fuel economy with a gasoline fuel economy including the energy impact of the distillers dried grain which becomes available to the livestock feeding industry.

ENERGY FOR CORN PRODUCTION

Energy requirements for the production of agricultural products vary considerably from country to country. In less developed areas the energy expended per unit of production is usually considerably lower than in highly developed areas in the world. On the other hand, the product production per unit of land is usually related to the energy expenditure and in those areas where less energy is being expended less product yield is being obtained. Table I compares the energy consumption and product production in Mexico with hand labor and with oxen power with that for a modern U.S. farm. The corn production with hand labor is very energy efficient requiring only 35,000 Btu's per bushel but the grain yield is only 31 bushels per acre. When the farmer adds an ox to assist in the corn production not only does the energy expended per bushel of grain increase, but the net grain yield per acre is cut almost in half because of the need to feed the ox. In a modern United States farm the energy expenditure per bushel of corn is about 3.5 times that for corn production with hand labor in Mexico, however, the yield of corn per acre is increased by a factor of 2.8. If large quantities of grain are to be produced it is important that the production per unit of land be maximized.

TABLE I.—COMPARISON OF ENERGY REQUIREMENTS FOR CORN PRODUCTION

	Mexico		United States modern farm
	Hand labor	Oxen power	
1,000 Btu per acre	1,084	1,572	10,510
Bushels per acre	31	15	86
Btu per bushel	39,000	104,800	122,200

Note: (1) Excludes energy for manufacture of farm machinery. (2) Data from Pimentel, D., and Terhune, E. C., "Energy and Food," Ann. Rev. Energy, 2, 171–195 (1977).

Table II shows the evolution of energy requirements for the production of corn in the United States between 1950 and 1975. Total energy consumption per acre including the energy for fuel, fertilizer, pesticides, herbicides, manpower, etc., but not including energy for the manufacture of the farm machinery increased from 3.8 million Btu's per acre in 1950 to 10.51 million Btu's per acre in 1975 (a factor of 2.8). The yield per acre in turn increased from 38 bushels per acre to 86 bushels per acre or a factor of about 2.3. During this same period the energy consumed per bushel of corn increased only 22.2 percent. In all cases the energy consumption expressed as equivalent gallons of oil consumed per bushel of corn was less than 1.

TABLE II.—ENERGY REQUIREMENTS FOR CORN PRODUCTION IN THE UNITED STATES, 1950–75

	1950	1959	1970	1975
1,000 Btu per acre	3,800	6,030	9,760	10,510
Bushels per acre	38	54	81	86
Btu per bushel	100,000	111,600	120,500	122,200
Gallon equivalent oil per Btu	0.67	0.74	0.80	0.81

Note: (1) Excludes energy for the manufacture of farm machinery. (2) 1 gal of equivalent oil equals 150,000 Btu. (3) Data from: (a) Pimentel, D., et al., Science, 182, 443–49 (1973). (b) Pimental, D., and Terhune, E. C., Ann. Rev. Energy, 2, 171–95 (1977).

While detailed fuel, fertilizer, and chemical consumptions are not yet available for 1979 these will probably be somewhat higher than the 1975 figures. On the other hand, it is estimated that the average yield of corn in 1979 will exceed 100 bushels per acre. Because the figures in Table II are average figures for the nation they include the energy requirements for an average amount of irrigation. Unirrigated corn will require less energy per acre for production while corn produced in arid areas will require more energy per unit of land area. For purposes of the energy comparisons contained in this paper the energy figure for 1975 was used.

ENERGY REQUIREMENTS FOR FUEL ALCOHOL PRODUCTION

When corn is fermented to produce alcohol a number of products are produced. The most desirable product is probably the grain alcohol (ethanol). However, small amounts of heavier alcohols known collectively as fusel oil are also produced in the fermentation. In the beverage industry the fusel oil is considered to be undesirable and a large amount of energy is expended in removing it from the grain alcohol. When one is manufacturing a fuel grade alcohol for use in blending Gasohol the fusel oil is a desirable component and should remain mixed with the grain alcohol rather than being removed. Fusel oil production is about 0.5 percent of the ethanol.

Table III contains a material balance showing the composition of the corn used for these calculations and the products produced. In addition to fuel alcohol a high protein cattle feed called distillers dark grain (DDG) is also produced in the fermentation process. As we shall see later inclusion of DDG in the cattle ration provides more weight than if the cattle had been fed the original corn which was used to produce the fuel alcohol and DDG. Carbon dioxide is a second byproduct produced in the fermentation but for purposes of this analysis has been assumed to be vented to the atmosphere.

TABLE III.—MATERIAL BALANCE, PRODUCTION OF FUEL ALCOHOL FROM CORN

Corn	Pounds per bushel	Products	Per bushel corn
Starch	34.07	Fuel alcohol	2.6133 gal.
Protein	4.73	DDG (10 percent H_2O)	18.016 lb.
Other	8.52	Carbon dioxide	16.886 lb.
Moisture	8.68	Alcohol losses	0.0531 gal.
Total	56.00	Remaining H_2O	3.4492 lb.

The recovery of alcohol by distillation is very efficient with a typical total loss of alcohol between the fermenter and the anhydrous product being only 2 percent. It is also interesting to note that there is sufficient moisture contained in the grain to supply the chemical needs for conversion of starch to alcohol and to account for the 10 percent moisture content in the distillers grains. All additional water added to the system is simply to produce appropriate concentrations and to provide streams of appropriate fluidity.

In the last few years there has been a dramatic reduction in the energy requirements for grain alcohol production mainly through more efficient heat recovery in the plant. Table IV compares the energy consumption in a beverage alcohol plant Circa 1973 with fuel alcohol plants designed in early 1978 and late 1979. The beverage alcohol plant consumed about 172,000 Btu's per gallon of alcohol produced. By early 1978 with the realization that there was no need to pro-

duce highly purified neutral spirits for fuel alcohol and with the introduction of modest heat recovery facilities the energy requirements dropped to 125,000 Btu's per gallon. By late 1979 in a recent plant design including use of furnace stack gases to dry the distillers grain and development of a pressure profile in the plant to increase potential heat recovery the energy requirement has dropped to 69,600 Btu's per gallon of alcohol produced. The heat of combustion of 1 gallon of anhydrous fuel grade alcohol is about 84,200 Btu's.

The energy consumption contained in Table IV include the fossil fuel consumption associated with the generation of the electrical needs for the alcohol plant as well as the fossil fuel burned in generating steam for the plant. For the overall energy analysis the late 1979 fuel alcohol plant energy consumption is used.

TABLE IV.—EVOLUTION OF GRAIN ALCOHOL PLANT ENERGY REQUIREMENTS

	Energy consumption (Btu's per gallon alcohol)		
	Beverage plant	Early 1978 fuel plant	Late 1979 fuel plant
190 proof spirits	109,000	68,000	52,900
Anhydrous alcohol	None	14,000	Included
Subtotal	109,000	82,000	52,900
DDG production	63,000	43,000	16,700
Total	172,000	125,000	69,600
Gallon equivalent oil per gallon alcohol	1.15	0.82	0.46

BASIS FOR ENERGY COMPARISON OF GASOHOL AND GASOHOL FUEL SYSTEMS

In making a consistent and valid comparison of the energy consumption in a Gasohol fuel system and in a gasoline fuel system there are a number of factors which must be considered. These factors include any decrease in fuel consumption (miles per gallon) between the two systems, any difference in fuel octane number between the two systems, any change in fuel volume between the two systems which may result from blending of the fuel components and any change in corn requirements that would be necessary to maintain equal quantities of beef production in both systems.

Research has been conducted to provide information about each of these factors. In Nebraska a two million mile road test program was conducted over a 34 month period in which the fuel economy of unleaded gasoline was compared with the fuel economy for Gasohol. Data from this test indicate the Gasohol fueled cars obtained on the average 6.7 percent more miles per gallon than the cars fueled on unleaded gasoline. For purposes of the energy comparison in this paper we have however, assumed that the Gasohol cars would obtain only 3 percent more miles per gallon.

Measurements by independent laboratories have shown that when a mixture is prepared containing 10 percent anhydrous ethanol and 90 percent unleaded gasoline the average octane, (R+M/2), is three numbers higher for Gasohol than for the unleaded gasoline used as the base stock. In this paper we have included this 3 octane number increase in the energy comparison. In blending 10 percent anhydrous ethanol with 90 percent unleaded gasoline laboratory measurements have shown that the total volume of the mixture is 0.23 percent greater than the sum of the volume of the components. For purposes of this paper this excess volume of mixing has been assumed to be zero.

Finally, feeding trials involving distillers dark grain (a byproduct of grain alcohol production) have shown that beef cattle receiving this component in their diet show increased weight gain over cattle not receiving this material. Tests carried out in Kentucky indicated that beef cattle receiving distillers dark grains from the fermentation of 20 percent of the corn fed to the animals gained 12.9 percent more weight than those cattle receiving the total ration of corn. Tests conducted in Nebraska support the conclusion that distillers dried grains are a better feed component than the whole corn from which they are produced. For purposes of this paper we have assumed that the increased weight gain associated with feeding distillers dark grains is 6 percent rather than the 12.9 percent reported from Kentucky.

The result of experimental observations and the evaluation basis used in this paper are contained in Table V.

TABLE V.—COMPARISON OF EXPERIMENTAL GASOHOL DATA WITH ENERGY EVALUATION BASIS

	Experimental observation	Evaluation basis
Increased MGP (percent)	6.7	3
Excess volume of mix (percent)	0.23	0
Increased octane (R+M/2)	3	3
Increased beef weight gain with DDG (percent)	12.9	6

CRUDE OIL SAVINGS ASSOCIATED WITH GASOHOL BLENDING

When one gallon of anhydrous grain alcohol is blended with 9 gallons of gasoline to produce 10 gallons of Gasohol there will be a reduction in crude oil requirements for the manufacture of automotive fuel. The most obvious reason for this is that grain alcohol has replaced gasoline in the mixture. Other factors also effect the amount of crude oil used including the fact that the 9 gallons of unleaded gasoline can be produced at a lower octane number because the addition of grain alcohol will raise the octane number of the blend to meet the market specification. Furthermore, because a car will travel further on one gallon of Gasohol than it will on one gallon of gasoline and since the automotive fuel market is a demand to drive a total number of miles, less gasoline will be needed to meet this demand.

The quantitative effect of these factors expressed as crude oil savings is shown in Table VI. By replacing one gallon of gasoline out of ten with one gallon of ethanol we save not only one gallon of crude oil but also a slight amount more because energy is not required to refine that gallon of crude oil. This saving by replacement amounts to 1.014 gallons of crude oil per gallon of grain alcohol. The requirements of a lower octane number for the 9 gallons of unleaded gasoline will save 0.286 gallons per crude oil per gallon of grain alcohol and obtaining 3 percent more miles per gallon with Gasohol will save 0.300 gallons of crude oil per gallon of grain alcohol for a total crude oil saving of 1.6 gallons. Information related to these crude oil savings was obtained from refinery simulation studies carried out by Bonner and Moore Associates, Inc. of Houston, Texas for the Department of Energy.

TABLE VI.—CRUDE OIL SAVINGS ASSOCIATED WITH GASOHOL PRODUCTION

	Gallons per gallon of alcohol
1. Replacement of gasoline with ethanol	1.014
2. Lower average octane number of gasoline	.286
3. 3 percent more miles per gallon with gasohol	.300
Crude oil saving	1.600

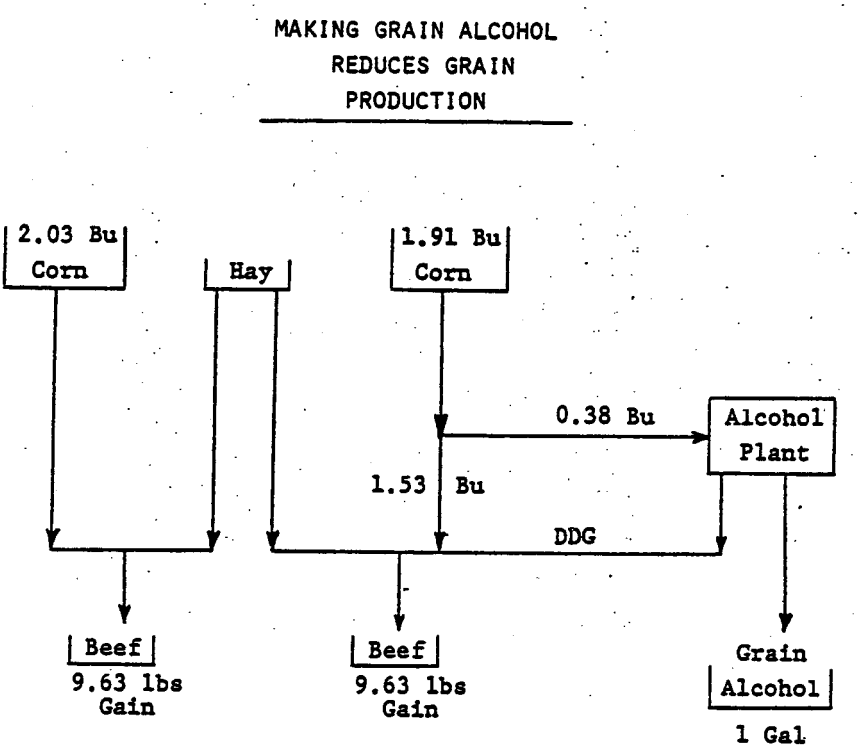
Note: Based on refinery simulation studies by Bonner & Morre Associates, Inc., Houston, Tex.

GRAIN SAVINGS ASSOCIATED WITH FEEDING DISTILLERS DARK GRAINS

Feeding trials at the University of Kentucky have demonstrated that inclusion of distillers dark grain (DDG) in a cattle ration results in increased weight gain. Specifically their results indicated an increased gain of 12.9 percent. As mentioned previously we have assumed for purposes of this study that the increased weight gain would be only 6 percent. Furthermore, beef production is geared to meeting a market demand for a certain number of total pounds. This means that with the inclusion of DDG in the animal ration fewer total bushels of corn are required to bring the cattle in full weight. This comparison is illustrated in Figure 1. When 2.03 bushels of corn are fed with an appropriate amount of roughage, (hay) the beeg cattle show a weight gain of 9.63 pounds. On the other hand, if we take 1.91 bushels of corn and divert 20 percent of this amount (0.38 bushels) to a grain alcohol plant we produce one gallon of grain alcohol. If we take the byproduct DDG from the alcohol plant and combine it with the remaining 1.53 bushels of corn and feed this with the same amount of hay to the beef

cattle they will also gain 9.63 pounds but with a reduced consumption of 0.12 bushels of corn. This savings of corn also represents a saving of energy.

Figure 1



COMPARISON OF ENERGY REQUIREMENTS FOR GASOLINE AND GASOHOL

In comparing the energy requirements for the production of gasoline and Gasohol with production of an equivalent amount of beef in each case we have reported the energies as gallons of equivalent oil. One gallon of equivalent oil is equal to 150,000 Btu's. The basis for this comparison is included in Table VII. We have assumed one gallon of fermentation fuel ethanol to be mixed with 9 gallons of unleaded gasoline in the Gasohol case and we have assumed for the gasoline case a sufficient amount of unleaded gasoline to move the car the same distance as in the Gasohol case. All other petroleum products produced in the refinery are the same in both cases. The quantity of corn in the two cases is as discussed in the preceding section and is sufficient to produce 9.63 pounds of beef weight gain. The energy requirement for producing this corn is presented in Table II for 1975.

Item 1 in Table VII indicates that for the gasoline case 10.74 gallons of crude oil must be refined to produce the base quantity of gasoline. In the Gasohol case only 9.14 gallons of crude oil are refined to produce the needed gasoline. The difference in these two quantities is the 1.6 gallons of crude oil savings detailed in Table VI. The second item in Table VII deals with corn production for cattle feed. In the gasoline case this is 2.03 bushels of corn as shown in Figure 1 with an associated energy expenditure of 1.65 gallons of equivalent oil. In the Gasohol case 1.53 bushels of corn were fed directly to the cattle. This corn has associated with it an energy consumption of 1.25 gallons of equivalent oil. Item 3 is the energy consumption associated with producing corn for ethanol manufacture. In the gasoline case there is no corn used for ethanol. In the Gasohol case as shown in Figure 1, 0.38 bushels of corn are associated with the production of 1 gallon of grain alcohol. Energy for the production of this corn is 0.31 gallons of equivalent oil. At this point the total petroleum consumption is 12.39 gallons of

equivalent oil in the gasoline case and 10.70 gallons of equivalent oil in the Gasohol case.

TABLE VII.—GASOHOL REDUCES FOSSIL FUEL CONSUMPTION

	Gallon equivalent of oil	
	Gasoline case	Gasohol case
1. Crude oil refining	10.74	9.14
2. Corn production for feed	1.65	1.25
3. Corn production for ethanol	0	.31
Subtotal, petroleum	12.39	10.70
4. Alcohol plant operation	0	.35
5. DDG plant operation	0	.11
Subtotal, coal	0	.46
6. Total, energy consumption	12.39	11.16
Fossil fuel saving with gasohol	1.23	

Basis: (a) 1 gal of fuel ethanol mixed with 9 gal of unleaded gasoline. (b) Unleaded gasoline to move a car as far as the gasohol in (a) above. (c) All other petroleum products are the same in both cases. (d) Corn and corn plus DDG to produce 9.63 lb of beef weight gain. (e) 1 gal of equivalent oil is equal to 150,000 Btu's.

In the Gasohol case we must now add the energy consumption associated with alcohol production and the DDG production. Using the figures from Table IV the energy consumption for a late 1979 fuel alcohol plant is 0.35 gallons of equivalent oil for the alcohol production and 0.11 gallons of equivalent oil for the DDG production. This energy would probably be supplied from coal so I have indicated the subtotal for the alcohol and cattle feed production as being coal with an energy content equivalent to 0.46 gallons of oil.

Summing the two subtotals we find that in the gasoline case energy equivalent to 12.39 gallons equivalent oil was consumed while in the Gasohol case energy equivalent to only 11.16 gallons of energy equivalent oil was consumed. Thus, we see that with Gasohol there is a fossil fuel saving equivalent to 1.23 gallons of oil for every gallon of grain alcohol that is blended with 9 gallons of unleaded gasoline. This is a very substantial saving.

Even if Gasohol did not show the 3 percent increase in fuel economy and even if the DDG did not produce a 6 percent weight gain in beef cattle the Gasohol case would still show an energy saving of 0.84 gallons of equivalent oil over the gasoline case. These energy savings exist whether the alcohol plant is fueled with coal, oil, or natural gas. If indeed, the alcohol plant is fueled with coal then the actual savings in petroleum are 1.69 gallons per gallon of alcohol blended.

The Department of Energy has estimated that the potential exists for producing about 4.5 billion gallons of grain alcohol from agricultural stocks in the near future if alcohol plants to match this capacity are built. At a saving of 1.69 gallons of petroleum per gallon of grain alcohol there is the potential of saving over 180 million barrels per year of imported crude oil. This in turn would reduce the outflow of dollars by at least $5 billion per year, which would be a significant percentage decrease in our trade deficit.

CONCLUSIONS

Based on the analysis presented above it has been demonstrated that replacement of gasoline with Gasohol in the automotive fuel market will result in a reduction of fossil fuel consumption. This reduction in fossil fuel consumption is present whether or not Gasohol provides greater fuel economy than gasoline and whether or not beef cattle gain additional weight when distillers dark grains (DDG) are included in their diet. The saving in petroleum that results from the production and use of Gasohol has the potential to reduce significantly our trade deficit.

APPENDIX

Table II contains a summary of energy requirements for 1975 corn production in the United States. A listing of the individual energy components in 1975 corn production is contained in Table A–1. This table shows that the three largest sources of energy consumption are fuel, fertilizer, and irrigation. Table A–2 contains the energy content of the corn grain and associated biomass material

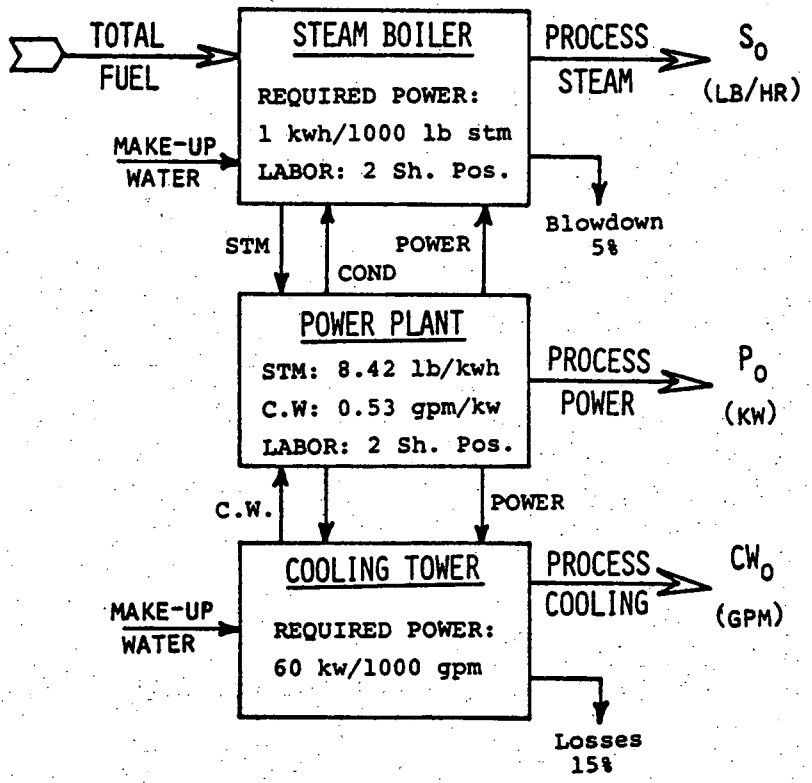
(stover and cobs). The energy production (810,000 Btu/Bu corn) is about 6.6 times the energy used in producing the corn.

Table IV contains the energy requirements for producing fuel grade ethanol and distillers dark grains in a late 1979 plant design. Table A–3 contains a detailed listing of the utility requirements for this late 1979 design. Using the relationship shown in Figure A–1 these utility requirements were converted to a total energy requirement of 69,600 Btu per gallon of fuel alcohol produced and includes the energy DDG production. The energy content of the grain stover from Table A–2 is about 2.6 times the energy requirement for producing ethanol and DDG. From Table A–4 it is apparent that the energy content of the products from the grain alcohol plant is approximately equal to the energy content of the corn used (Table A–2) even though the mass of the products is only 63% of the mass of the corn used (Table III).

FIGURE A - 1

BLOCK FLOW DIAGRAM

UTILITY - FUEL RELATIONSHIP



$$\text{Total Power } P_T \text{ (kw)} = 1.05(P_o + .00105S_o + .0706CW_o)$$

$$\text{Total Fuel (Btu/Hr)} = 10{,}000P_T + 1.32S_o\Delta H$$

TABLE A-1.—ENERGY CONSUMPTION IN CORN FARMING, 1975

Component	Btu's per bushel of corn	Btu's per gallon of EtOH
1. Seed corn	2,700	1,040
2. Fertilizer	43,900	16,800
3. Herbicides	2,700	1,040
4. Insecticides	1,500	580
5. Fuel	39,300	15,030
6. Electricity	7,100	2,720
7. Irrigation	14,600	5,580
8. Drying	7,000	2,680
9. Transportation	3,400	7,290
Total, energy	122,200	46,760

Data from Pimentel, D., Terhune, E. C., Ann. Rev. Energy, 2, 171 (1977).

TABLE A-2.—ENERGY PRODUCTION IN CORN FARMING

Component	Btu's per bushel of corn	Btu's per gallon of EtOH
1. Corn, digestible energy	342,000	130,000
2. Stover and cobs, high heat value	468,000	180,000
Total, energy	810,000	310,000

TABLE A-3.—UTILITY AND ENERGY CONSUMPTION IN GRAIN ALCOHOL PRODUCTION (LATE 1979 DESIGN)

Plant section	Per gallon of fuel ethanol			
	Pounds steam	Kilowatt-hours	Gallons C.W.	Total Btu's[1]
1. Milling and propagation	0.22	0.349	2.7	4,000
2. Cooking and saccharification	11.56	.034	41.4	18,030
3. Fermentation	.06	.053	19.0	650
4. Distillation	20.46	.021	54.8	31,500
5. Thin stillage concentrate	3.00	.357	3.4	8,340
6. DDG drying and other	1.18	.503	45.4	7,080
Total	36.48	1.317	166.7	69,600

[1] Calculated using the listed utilities and figure A-1.

TABLE A-4.—ENERGY PRODUCTION FROM A GRAIN ALCOHOL PLANT

Component	Btu's per gallon of EtOH
1. Fuel ethanol, higher heating value	84,200
2. DDG, digestible energy	45,000
Total energy	129,200

APPENDIX II

[From the Lincoln Star, Mar. 25, 1980]

MOBIL, SAUDIS AGREE TO $2 BILLION CHEMICAL PROJECT

NEW YORK (AP).—Mobil Corp. and the Saudi Arabian government have agreed to build a $2 billion petrochemical complex on the country's Red Sea coast, Mobil said Monday.

The complex will be located in Yanbu, the site of a planned $1 billion oil refinery project which also will be owned by the Saudis and Mobil, the second-largest oil company in the United States.

The 250,000 barrels-a-day refinery and the chemical project will be supplied by a 750-mile oil and natural gas pipeline system linking the western city with oilfields in the country's east.

Mobil said construction of the chemical complex will start next year. By 1985, it said, the complex will be able to produce 1 billion pounds a year of ethylene and other products used to manufacture plastics and synthetic fibers.

Mobil and the Saudi Basic Industries Corp. will be equal partners in the chemical complex, whose construction will be financed in large part by a loan from the Saudi government, Mobil spokesman John Flint said.

Mobil is one of four international oil companies which own Arabian American Oil Co.

[From the Wall Street Journal, Apr. 2, 1980]

MOBIL OIL WINS $154.2 MILLION CONTRACT FROM U.S. DESPITE NEW REBUKE BY CARTER

(By a Wall Street Journal Staff Reporter)

WASHINGTON.—Mobil Oil Corp. got a new rebuke from President Carter and a new $154.2 million contract from the Defense Department.

The jet fuel contract, issued by the Defense Logistics Agency, was announced only a few hours after the President renewed his criticism of the Mobil Corp. subsidiary for what he said were violations of the government's voluntary price guidelines. Yesterday's criticism, before a meeting of construction union members, was essentially a replay of the tongue-lashing the President gave Mobil Friday.

At that time, the Council on Wage and Price Stability said it was adding Mobil's name to a list of concerns that may be barred from getting government contracts of $5 million or more.

[From the Wall Street Journal, Mar. 24, 1980]

MOBIL CORP. UNIT PLANS PROJECT WITH GERMANY TO CONVERT METHANOL

(By a Wall Street Journal Staff Reporter)

NEW YORK.—Mobil Oil Corp. announced plans for a joint West German-U.S. pilot plant program to convert methanol to high-octane unleaded gasoline.

The Mobil Corp. unit said the plant, which will use Mobil technology, will be built at Wessling, West Germany. Its $35 million cost will be shared by the U.S. Energy Department, Germany's ministry for research and technology, two German concerns that will be involved in its construction and operation, and Mobil.

The plant will process 100 barrels of methanol a day, Mobil said. The methanol is methyl alcohol, often produced from natural gas or coal. Mobil has operated a much smaller four-barrel-a-day pilot plant at its Paulsboro, N.J., research laboratory for the past two years.

The company said the German-U.S. program will "provide the data necessary to establish an efficient and cost-effective process for producing synthetic gasoline on a commercial basis." The plant should be completed during 1983, Mobil said.

[From the Wall Street Journal, Apr. 2, 1980]

GASOLINE-FROM-GAS PROCESS IS SCHEDULED FOR NEW ZEALAND USE—MOBIL UNIT'S VENTURE PLANS TO PRODUCE 12,500 BARRELS A DAY BY THE MID-1980S

(By a Wall Street Journal Staff Reporter)

NEW YORK.—Mobile Oil Corp. plans to make gasoline from natural gas using a processs that first turns the gas into methanol.

The Mobil Corp. unit said it will sign a preliminary agreement today with the New Zealand government for a plant that will make 12,500 barrels a day of high-octane gasoline, beginning in the mid-1980s.

The plant will use a Mobil-discovered catalyst that converts methanol into gasoline, Mobil said. Methanol can be produced from either natural gas or coal, using proven technology, the company added.

Mobil added that the methanol-to-gasoline plant will use natural gas from New Zealand's large Maui field.

In addition to the use of its process in the New Zealand project, Mobil Oil will have a 25 percent interest in the venture. Mobil didn't disclose the cost of

the project, but previous estimates from New Zealand have placed the cost at about $380 million.

[From the World-Herald Bureau, May 22, 1980]

DEALER: GASOHOL BENEFITS NATION

(By Mary Kay Quinlan)

WASHINGTON.—Herb Staretz runs a Mobil gas station in Passaic, N.J., where farming isn't exactly big business.

But he said he'd like to see American farmers benefit if he sells Gasohol, because if they benefit, the whole country does, too.

Gasohol "benefits American farming and it benefits the American people by keeping American dollars here in the United States," Staretz said Wednesday. "We're all one country."

The New Jersey dealer indicated, however, that he's beginning to think the interests of the nation are the farthest thing from Mobil's mind.

The oil company has notified him that it will terminate his lease because he began selling Gasohol, in violation of company policy.

The company says its round gas pumps are a trademarked item and that selling anything but Mobil gasoline from them is prohibited.

Staretz said he clearly marked the pump dispensing Gasohol with two disclaimers on each side making clear the alcohol-grain gasoline mixture was not a Mobil product.

The terms of his lease with Mobil are "stacked in the company's favor," he said.

Staretz is one of about 50 New Jersey dealers selling Gasohol under a promotion effort under taken by the state's gasoline retailers association.

"What we're trying to do (by selling Gasohol) is give our customers a hedge against the next shortage coming up," he said.

While the market for gasoline is soft at the moment, making it "hard to get rid of gasoline," that situation won't last, and tight supplies can be expected again, possibly by fall, Staretz said.

Staretz, who attended a hearing on a bill that, if it were law now, would prevent Mobil from ending his lease, said Mobil's policy makes clear the firm is not interested in conservation, which is one of the advantages of Gasohol.

"All they're interested in is the bottom line," he said.

Staretz said lawyers told him he'd be "taking a very big chance" by selling Gasohol.

"I'm putting my station on the line. "If I go down the drain . . . many other dealers will be in the same boat."

[From the Wall Street Journal, May 8, 1974]

DUTIES ON METHANOL, ZINC CONTENT OF ORE SUSPENDED BY HOUSE

(By a Wall Street Journal Staff Reporter)

WASHINGTON.—The House easily approved the suspension of tariff duties on the zinc content of zinc ore and on methanol imported for use as a fuel.

The current zinc-ore duty of 0.67 cent a pound would be suspended until July 1, 1977, resulting in an annual revenue loss of about $3 million for the government.

Zinc ore, which also generally contains copper and lead, is used extensively in steelmaking. Congress has suspended the duty on the copper content, but the lead content still is subject to tariff.

The 7.6-cent-a-gallon duty on methanol, or wood alcohol, would be eliminated entirely when imported into the U.S. to be used as a fuel, but still would apply when the methanol is for use as a chemical. Currently, very little methanol is imported for use as a fuel, but it's hoped that suspending the duty will eventually result in a new fuel supply.

The Senate still must act on both measures.

[From the C&EN, May 26, 1980]

METHANOL PLANT FOR SAUDI ARABIA

Mitsubishi Heavy Industries in Tokyo says it has a contract from Saudi Methanol Co. to supply a 600,000 metric-ton-per-year (1.32 billion lb-per-year)

methanol plant at Al Jubail near the Persian Gulf in Saudi Arabia. To cost about $195 million, the plant is due for completion at the beginning of 1983. Five sixths of the product methanol will go to Japan.

METHANOL IN ARABIA

Celanese—600,000 metric tons/yr.
Shell—600,000 metric tons/yr.
Japanese Cons. 600,000 metric tons/yr.
Saudi Methanol Co. 600,000 metric tons/yr. (see above).
Total: 2,400,000 metric tons/yr., 52,300 bbls/day, 2,200,000 gal/day.

Senator MCGOVERN. Thank you very much for your statement, Professor Scheller.

Our next witness is Mr. Alfred Campbell of Mar-Cam Industries, Glenside, Pa.

STATEMENT OF ALFRED M. CAMPBELL III, COFOUNDER, MAR-CAM INDUSTRIES, GLENSIDE, PA.

Mr. CAMPBELL. Thank you, Senator McGovern.

I am Mo Campbell. My testimony today will not focus on the technical issues of the ERAB report but, rather, an overview of where it fits into the whole development of gasohol.

In July 1978, along with my partner Buzz Marcus, I cofounded Mar-Cam Industries of Glenside, Pa. Currently Mar-Cam ranks as America's No. 1 independent gasohol marketing company and supplies 200 proof agriculturally derived ethanol to almost 75 independent oil jobbers and over 1,500 independent stations. Only Texaco markets gasohol through more outlets. Last spring Mar-Cam brought gasohol to the east coast.

Buzz Marcus and I, in joint testimony December 5, 1978, before the Department of Energy Alcohol Fuels Policy Review stated:

It is absolutely necessary to stimulate and develop consumer buying patterns for gasohol fuels before increased alcohol productivity comes on-line.

Consumer acceptance and large volume purchasing must be done before new distilleries are ready so that a real market will exist for the new alcohol produced.

Also, actual large scale retailing and consumer acceptance form the most realistic, conservative, and logical foundation for making financial considerations regarding private sector funding of proposed new plants.

It is bad economic or financial policy to fund new distillery construction if no major market for new alcohol production has ever been realistically proven, by actual sales volume, to exist.

In interpreting today's comments on ERAB, it is essential to comprehend the concept of a consumer demand factor that exerts a "pull" mechanism on alcohol production. If that "consumer demand pull" is reduced, either by limiting the growth of gasohol marketing or by generic opposition to the gasohol concept, then the resulting factor of alcohol production will also be reduced which works completely against the patriotic goal of energy self-sufficiency through increased production of alternative domestic American fuels. Therefore, if one set out to undermine gasohol, you need only slow down retail marketing and discredit gasohol's factual foundations to effectively bottleneck its growth and also slow down the Nation's development of renewable alternative fuels.

These tactics have been employed insidiously by the Mobil Oil Corp. for several years, as I have stated in previous testimony.

Let me point out that as a small, newly created business, Mar-Cam must either be insane to attack head on the major oil companies, or simply fighting for survival. In this case our best defense has been an aggressive offense. It is an offense that takes me away from my partner and out of my office where our business is actually conducted. Every time I have to run to Washington to pour water on some fire, such as the ERAB/Mobil Gate dilemma, I am hurting my principal business of gasohol sales through developing and increasing gasohol outlets. In other words, when I am forced out of the office I can't get my primary day-to-day business accomplished.

The grassroots movement for gasohol has been one of dedication by hundreds of thousands of Americans spending their personal time and money to implement gasohol. The ability of the major oil companies, principally Mobil, by virtue of sheer economic and political vastness to spread negative comments on gasohol, has been overwhelming. The accumulated damage to the free, rapid, and necessary development of gasohol by an antigasohol campaign is astronomical.

To acknowledge the extent of the effort put forth by Mobil to harass gasohol marketing and discredit its conceptual foundations, you need only read through the enclosed material.

First, sir, is a letter of July 17, 1979, to one of my independent distributors saying cease and desist using Mobil equipment for the sale of gasohol. Also, it says cease and desist using the Mobil credit card for the sale of gasohol. Mobil has termed this letter in numerous testimony as "unfortunate."

The next letter, last month, they wrote to Herbert Staretz in New Jersey terminating his contract. It says: "Turn in your keys July 31." They talk about: "You have been selling non-Mobil product gasohol through a Mobil round pump. This is an infringement of our trademark. This constitutes a deceptive trade practice and violation." However, as submitted in antitrust testimony, I believe before the House, Charles Johnson, a Mobil truckdriver, in a sworn affidavit, says numerous times that he picked up Gulf, Citgo, and BP products and then would drive directly to a Mobil station and put it in their tanks and it would therefore be sold as Mobil product in Mobil pumps, and he also, in another affidavit, swore that nothing was ever added to that tank.

To show again how Mobil has gone on the road, on June 1 and June 2, in Philadelphia and Washington, of 1978, a letter by Mr. Penick, the president of Mobil research and development, which theoretically, therefore, becomes Mr. Weisz' boss, actively attacks gasohol in a campaign set throughout the country.

Mobil policy continues in a March 22 letter to a Mr. Roger Cotner in The Plains, Va., just asking for information on gasohol. They state that the average car will not run with gasohol properly and then they stated policy: "We feel that our Nation could get much more useful energy out of these materials," meaning alcohol from grain, "by burning them under boilers instead of creating them into ethanol alcohol." Then they state Mobil policy: "We do not see grain alcohol as a viable motor fuel."

This spring one of my dealers sent me a clipping in the Atlantic City Post saying: "What can be done about this harassment?" It's an Atlantic City Post article where a Mobil executive tells young students that gasohol does not offer energy solutions. They are out campaigning and coincidentally, a compatible article from the Philadelphia Inquirer, where Mobil's president says: "Forget energy panaceas such as gasohol, solar energy or military options in the Mideast in favor of domestic development of oil, nuclear power and coal." The president of Mobil said this in Philadelphia to a meeting of financial analysts, again attacking the funding of development of gasohol.

And finally, the very recent article that has appeared in the Washington Post, the advertisement. I called Mobil yesterday. That advertisement didn't only appear in the Washington Post, the Washington Star, and the New York Times. It also appeared in the Boston Globe, the Atlantic Journal, the Houston Chronicle, the Dallas News, Los Angeles Times, Chicago Tribune, the Christian Science Monitor, and the Wall Street Journal. This probably cost $35,000 last week.

It is small wonder that most members of the grassroots movement behind gasohol feel that Mobil is the industry's number one antagonist. It is therefore equally small wonder that we question the objectivity of the ERAB report, considering the inclusion of Mr. David Pimentel, the gasohol study group's chairman who has served as a paid consultant to Mobil, and Paul Weisz, a Mobil Oil Co. research and development executive. The ERAB gasohol study group's objectivity is also challenged in light of the fact that Mr. William Scheller's pro-gasohol report was "lost" and Mr. Scheller was informed that the group did not care to receive an additional copy of his input.

The following quote is a statement I made on December 19, 1979, at a Senate oversight hearing at the Department of Energy's Office of Competition, and it ironically seems like a current summary of the ERAB report's conclusions and ensuing controversy.

> We see only one man with technical alcohol research experience, Mr. William Scheller, on the Energy Research Advisory Board, and wonder how an objective analysis of alcohol fuels can be achieved in spite of a lack of alcohol fuels experience by the majority of ERAB members. Also, it appears that Dr. Deutch in DOE strongly favors stepped up commercialization of synthetic fuel projects based on an oil shaled, a SASOL type coal liquifaction process, or the highly touted Mobil Oil Company's coal to gasoline conversion, in spite of massive environmental, cost, time and inefficient energy balance obstacles.

Recently I wrote several major engineering firms requesting information on the energy balance and production costs associated with their processes. Vulcan Cincinnati, Chemapec, Day, and Zimmerman, and Mr. Paul Middaugh, all responded within 10 days with positive energy balances and alcohol production costs that ranged from 70 cents per gallon to $1.22 per gallon. Also, the Department of Energy supplied a publication entitled "Preliminary Energy Balance and Economics of a Farm Scale Ethanol Plant." The net energy balance output ratio was positive by 278 percent versus the energy input and the cost of production was $1.20 per gallon. I guess no one on the ERAB board bothered to look into the practicability of onfarm plants or to read material easily obtainable from within the DOE.

When you stop to consider that the 15 billion gallons per year milk industry is a cottage industry that is producing in increments of one squirt at a time, you realize that it would require a blatantly nonob-

jective position to exclude the vital contribution that the farming community can make to America's energy resources through small scale appropriate technology alcohol production. If world war III were to begin today and America's imported oil supply were cut off, it would be the farmers of this nation who would be ready immediately with new energy production through alcohol from fermentable crops.

Conversely, it appears that it is the farmers who currently suffer from ERAB's lethargic, status quo, tunnel-visioned analysis of "alternative energy potentials." As a response to my requesting for scientific engineering information on the technical issues of potential domestic ethanol production and relative energy balance, Mr. Kendall Pye and John Ferchak of the University of Pennsylvania in Philadelphia completed a study for today's hearings and is releasing it for the first time ever to this committee. Professor Ferchak has come from Philadelphia and is here with me to answer any technical questions the committee might have, however, I now shall report a summary of the dramatic findings established by this study.

First of all, it's very compatible with the figures used by Mr. Commoner. It says 5.5 to 30 billion gallons of ethanol could be produced in the short term with no evident impact on food production. Also, high yield sugar crops could add an additional 10 billion gallons of ethanol production by the year 2000. Cellulose conversion of waste products from agriculture, forests, and municipal wastes could yield an additional 36 billion gallons of 192 proof ethanol of 2000.

Finally, silvaculture or forestry could produce over 100 billion gallons of ethanol from cellulose conversion with no conflict on food production.

Senator, this means we could totally displace petroleum as a basis for our high quality liquid fuel needs, if America ever adopted such a policy. In light of this revolutionary study, it is easy to comprehend the opposition to the concept of gasohol and renewable alcohol by the major oil companies, especially in light of Exxon's announcement to commit $800 million to nonrenewable synfuels from coal and oil shale, which would compete directly with such generic renewable energy sources as alcohol, solar power, wind, water, and geothermal sources.

Senator McGovern. Mr. Campbell, I wonder if you would, in the interest of time, be willing to insert the rest of your prepared statement in the printed record and then we'll get back to some of these points in the questions and answers.

Mr. Campbell. All right; I will conclude. Many Members of Congress have shown their opposition and are moving ahead. I feel, however, that the public should move ahead with consumer pressure. I have boycotted the Mobil Oil Co.'s products for the last 2 years because of their negative approach to gasohol and I urge people to look into the analysis of Mobil's role and actions over the past 3 years and if a consumer feels that Mobil has acted against the consumer's best interest or the best interest of the Nation, I urge them to participate in a constructive consumer boycott of Mobil Oil Co.'s premium unleaded gasoline by substituting his purchase with gasohol, a 90-plus octane unleaded that was rated by 42 percent of the Iowa motorists surveyed to be "as good or better than premium unleaded gasoline."

Thank you, sir.

[The prepared statement of Mr. Campbell, together with additional material for the hearing record, follows:]

PREPARED STATEMENT OF ALFRED M. CAMPBELL III

Good morning Mr. Chairman and members of the Joint Economic Committee. I am Mo Campbell. In July 1978, along with my partner Buzz Marcus, I co-founded MAR-CAM Industries of Glenside, Pennsylvania. Currently MAR-CAM ranks as America's No. 1 Independent Gasohol Marketing Company, supplying 200 proof agriculturally derived ethanol to almost 75 independent oil jobbers and over 1,500 independent stations. Only Texaco markets Gasohol through more outlets. Last spring MAR-CAM brought Gasohol to the East Coast and is responsible for the first retail Gasohol sales ever in Missouri, Virginia, Maryland, South Carolina, Delaware, Pennsylvania, New Jersey, and the District of Columbia.

The almost 75 independent oil jobbers with whom MAR-CAM Industries works represents non-branded outlets of the gasoline products of Texaco, Arco, Gulf, Mobil, Union 76, Phillips, Sunoco, BP, Citco, Shell, and Amoco, Distribution currently ranges along the East Coast from Maine to Florida and as of this week, as far west as California.

Buzz Marcus and I, in joint testimony December 5, 1978 before the Department of Energy Alcohol Fuels Policy Review stated, "It is absolutely necessary to stimulate and develop consumer buying patterns for Gasohol fuels before increased alcohol productivity comes 'on line.' Consumer acceptance and large volume purchasing must be done before new distilleries are ready so that a real market will exist for the new alcohol produced.

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These tactics have been employed insidiously by the Mobil Oil Corporation for several years as I have stated in previous testsimony before the House Small Business Anti-Trust and Restraint of Trade Subcommittee (September 1979), the National Alcohol Fuels Commission (October 1979), the Senate Committee on Government Affairs Subcommittee on Energy (December 1979), and the Joint United States Senate Judiciary Committee Subcommittee on Anti-Trust and the United States Senate Committee on Small Business (March 5, 1980).

Let me point out that as a small newly created business MAR-CAM must either be insane to attack head on the major oil companies, or simply fighting for survival. In this case our best defense has been an aggressive offense. It is an offense that takes me away from my partner and out of my office where our business is actually conducted. Everytime I have to run to Washington to pour water on some fire, such as the ERAB/Mobil Gate dilemma, I am hurting my principal business of Gasohol sales through developing and increasing Gasohol outlets. In other words, when I am forced out of the office I can't get my primary day to day business accomplished.

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Dr. Kendall Pye and John Ferchak of the University of Pennsylvania completed a study for today's hearings and is releasing it for the first time ever to this committee. Professor Ferchak has come from Philadelphia and is here with me to answer any technical questions the committee might have, however, I now shall report a summary of the dramatic findings established by today's University of Pennsylvania study.

Namely: 5.5 to 30 billion gallons of ethanol could be produced in the short term (time is dictated by lead time in distillery construction phase) with no impact on food production. (This represents from 5 percent to 27 percent of the U.S. annual gasoline consumption of 110 billion gallons.)

Also high yield sugar crops could add an additional 10 billion gallons of ethanol production by the year 2000.

Cellulose conversion of waste products from agriculture, forests, and municipal wastes could yield an additional 36 billion gallons of 192 proof ethanol by 2000.

Finally silvaculture or forestry could produce over 100 billion gallons of ethanol from cellulose conversion with no conflict on food production.

Mr. Chairman and Members of the Committee, this means we could totally displace petroleum as a basis for our high quality liquid fuel needs, if America ever adopted such a policy. In light of this revolutionary study it is easy to comprehend the opposition to the concept of gasohol and renewable alcohol by the major

oil companies, especially in light of Exxon's announcement to commit $800 billion to non-renewable syn fuels from coal and oil shale, which would compete directly with such generic renewable energy sources as alcohol, solar power, wind, water, and geothermal heat sources.

In reference to energy balance the University of Pennsylvania study points out that the amount of high quality liquid fuel used to produce nine gallons of ethanol would be one gallon for a net positive energy balance ratio of 9 to 1.

Material received in my office June 5, 1980 from the *London Oil Reports* stated, "Expected shortages mean the cost of crude—which doubled in the last year—could reach $135 per barrel by 1990." I therefore feel in light of Penn's dramatic conclusions plus the alarming increase in crude oil costs that have occurred and are predicted to occur that, over the next ten years, renewable ethyl-alcohol will be cheaper to produce than gasoline and that America should massively re-apportion its synthetic fuels budget behind ethanol and should clearly state domestic renewable energy sources as its highest priority.

I find it incredible that I would generate such strongly positive responses from those engineering companies and from the University of Pennsylvania by simply sending out a letter of inquiry and therefore question how the ERAB Gasohol Study Group could possibly have assembled such a collection of negative and pessimistic views without specifically attempting to reach those views prior to an objective scientific analysis of the issues.

At stake, however, is the issue of overall credibility of the alcohol fuels movement. By discrediting and under estimating the efficiencies and usefulness of the technologies associated with alcohol fuels a DOE-sponsored report would clearly be utilized by our antagonists to challenge the wisdom and value of any financing of alcohol fuels projects, both small scale and industrial sized, whether it be from private sector funding or from the large government appropriations available in S–932 and other government programs.

Many members of Congress have become enraged over the opposition to gasohol and the attacks leveled upon ethanol production. We urge Congress to pursue every means available to it to ease the obstacles. Congresswoman Smith and Congressman Daschle have encouraged the General Accounting Office to pursue an investigation of the ERAB program with special attention to the role of John Deutch. Senator Metzenbaum has sponsored the Gasohol Competition Act of 1980 which would prohibit interference with gasohol marketing and with credit card usage associated with its marketing. Congressman Bedell has sponsored a bill calling for divorcement from direct retail gasoline and gasohol marketing by the fully integrated major oil companies. I applaud the government in all of these positive steps to aid gasohol and alcohol fuels. However, as Congress proceeds in its manner so must the citizens proceed in their manner.

For the past two years I have maintained a policy of boycotting the products of the Mobil Oil Corporation due to their negative position regarding gasohol and renewable alcohol fuels. I have focused my individual consumer power away from Mobil. I urge the American public to look at Mobil's three-year profile on gasohol. If, after personal analysis of Mobil's role and actions, a consumer feels that Mobil has acted against that consumer's best interests and the best interests of our Nation, then I urge that person to participate in a constructive consumer boycott of Mobil's premium unleaded gasoline by substituting its purchase with gasohol, a 90-plus octane unleaded that was rated by 42 percent of the Iowa motorists surveyed to be "as good or better than premium unleaded gasoline."

Consumer power is dollar power. Working together and coupled with the Congressional and political power that is currently being employed in this case great results are possible. Mobil can be shown the way, by the will of the American public, to marketing of gasohol.

In conclusion I urge everyone to buy gasohol and support the concept of domestic renewable energy. Consumers should look for the independent service stations and oil jobbers throughout America who have risked their own money, time, equipment, and business and personal reputations to first pioneer this alternative energy. If no independent stations are available with gasohol I suggest Texaco, Amoco, or Citgo brand gasohol, for these are the sincere marketers of gasohol among the major oil companies. Put your consumer power behind your convictions. Show your support of renewable alternative energy. Buy gasohol because it is the high octane unleaded that's good for your car and good for your country.

MOBIL OIL CORP.,
Ft. Lauderdale, Fla., July 17, 1979.

Mr. BILL BIRD,
Bird Oil Co.,
Hilton Head, S.C.

DEAR MR. BIRD: We have received notification and also confirmation from our conversation with you that you have been using Mobil equipment for the sale of gasahol to the consuming public. We should inform you officially that this constitutes adulteration of Mobil products in violation of state law. It is also a deceptive trade practice and is also an infringement of our trademark round pump. We hereby request that you immediately cease and desist from this practice.

Further, we have also been informed that you have been using the Mobil credit card for the sale of gasohol. Please be informed that our credit policy is intended to only cover the sale of Mobil products and it is not our intention nor is it our obligation to provide credit for the sale of a third party product. Accordingly, you are hereby requested to cease and desist from the use of Mobil credit cards in the sale of gasohol.

Respectfully yours,

J. A. BLESSIN,
Acting District Manager.

OFFICIAL FILE COPY

APRIL 24, 1980.

Mr. HERBERT STARETZ,
38 Shurebrook Parkway,
Livingston, N.J.

DEAR MR. STARETZ: Please take notice that Mobil Oil Corporation hereby elects to non-renew and does hereby terminate our Retail Dealer Contract and Service Station Lease dated December 8, 1978, together with our Equipment Loan Agreement dated April 10, 1979, and to non-renew its franchise relationship with you. Our franchise agreements and relationship will terminate on the 31st day of July, 1980.

The reasons for this termination and non-renewal of the franchise agreements and the franchise relationship are as follows:

1. You have utilized, and continue to utilize, Mobil equipment for the sale of a non-Mobil product. This violates Paragraph 7(d) of the Service Station Lease, Paragraph 6 of the Retail Dealer Contract, and Paragraph 2 of the Equipment Loan Agreement. The obligation imposed by these contractual provisions, to which you agreed to comply, is both a reasonable and materially significant provision to our franchise relationship.

2. You have sold, and continue to sell, to the motoring public, a non-Mobil product (gasohol) through a Mobil round pump, which is a trademark of Mobil Oil Corporation. The round pump is a distinctive symbol or trademark which stands for Mobil product. This act not only violates Paragraph 6 of the Retail Dealer Contract, but also constitutes an infringement of our trademark.

3. You have sold, and continue to sell, to the motoring public, a non-Mobil product (gasohol) through Mobil's round pump, which is a trademark of Mobil Oil Corporation. This constitutes a deceptive trade practice in violation of the Federal Trade Act (15 U.S.C. ss45).

4. You have sold, and continue to sell, to the motoring public, a non-Mobil product (gasohol) without sufficient notice to the public that this commodity is not a Mobil product. This action violates New Jersey's Consumer Fraud Act (N.J.S.A. 56:8-8.1 et seq.).

AFFIDAVIT

STATE OF NEW JERSEY, COUNTY OF PASSAIC, SS:

I, Charles Johnson, of full age, being duly sworn according to law upon my oath, depose and say:

1. I am a former employee of Mobil Oil Corporation.

2. I had been employed by Mobil for more than ten (10) years as a truck driver for the purpose of delivering loads of gasoline to Mobil dealers in New Jersey, and I operated out of the Linden terminal.

3. On numerous occasions, when Mobil ran out of its own gasoline products, I was sent to the terminals of competing companies, such as Gulf, Citgo and BP and picked up gasoline from them.

4. On these occasions, I would then drive to Mobil dealers and deliver to them the gasoline that I had picked up from the other companies, as a substitute for Mobile gasoline.

5. These substitute deliveries were not isolated instances but were done regularly over a period of time, and I know from my conversations with other drivers that I was not the only driver who made substitute deliveries.

Sworn and subscribed to before me this 7th day of March, 1980.

CHARLES JOHNSON.

Notary Public of New Jersey.

GLORIA ENGELHARDT.

[From the Washington Post, June 2, 1978]

WHY THE GASOHOL CONCEPT "EVAPORATES"

You recently ran a column by Jack Anderson advocating the conversion of food grains to "gasohol" for automobile fuel. That may sound like an attractive idea to some people, since grain can be considered a renewable domestic resource. Unfortunately, the gasohol concept evaporates under careful investigation.

The problem is not whether gasohol (a mixture of 10 percent grain alcohol and 90 percent leaded gasoline) will run a car. While tests show that the average car will not run or control emissions as well with gasohol as with ordinary gasoline, many motorists would never know the difference.

Even the high price of grain alcohol—three times the price of gasoline at wholesale—could be offset at taxpayers' expense, if gasohol would really "reduce the outpouring of dollars to the oil potentates" as Mr. Anderson asserts. But it would not. Imports would go up, not down, because the process of growing, fermenting and distilling grain consumes more energy than it produces. A new Department of Agriculture report puts it this way: "Converting corn energy to automobile fuel results in a negative energy balance."

Agriculturalists calculate that it takes twice as much energy (in the form of diesel fuel, gasoline, fertilizer, fuel oil, etc.) to grow the corn and operate the distillery than is contained in the final product.

In other words, the more gasohol we use, the more foreign oil we import.

It's true that alcohol could be made from sources noted by Mr. Anderson—agricultural and timber wastes, garbage, urban trash—at high costs and in small volumes. The nation could get more useful energy out of those materials by burning them under boilers to generate electricity, however, as is being done now in St. Louis, Chicago and other cities.

There's another kind of alcohol. It's called methanol, or wood alcohol, and it can be made from the nation's abundant reserves of coal. Methanol doesn't make good gasohol, but Mobil has invented a way to transform it into high-octane gasoline. It is not cost-competitive today, but when we run short of crude oil, we will have an alternate source of automobile fuel—not alcohol made from grain, but gasoline made from alcohol made from coal.

NEW YORK, N.Y., *March 22, 1979.*

Mr. ROGER G. COTNER,
The Plains, Va.

DEAR MR. COTNER: Thank you for your letter requesting information on gasohol. Mobil Research is very much involved in developing alternate energy sources, and we particularly are interested in the potential of alcohol fuels.

Recently, much more attention has been focused on the ability of "gasohol" (a mixture of 10 percent alcohol and 90 percent gasoline) to help solve the country's dependence on foreign imports. Tests have been conducted with a number of cars, and some do run better on gasohol, although most do not. The average car will not start up, run, or control emissions as well with gasohol as with gasoline.

However, the basic problem is not whether gasohol will run your car. What really makes gasohol invalid is that growing, fermenting, and distilling grain consumes more energy than it produces. Agriculturalists calculate that it takes twice as much energy (in the form of diesel fuel, gasoline, fertilizer, fuel oil, etc.) to grow the corn and operate the distillery than is contained in the final product. In other words, the more grain alcohol we make, the more foreign oil we import.

It is true that grain alcohol can be made from many sources, such as agricultural and timber wastes, garbage, and urban trash, but at high costs and in small volumes. We feel that our nation could get much more useful energy out of these materials by burning them under boilers to generate electricity, such as being done now in St. Louis, Chicago, and other cities.

While we do not see grain alcohol (or ethanol) as a viable motor fuel, we are very much interested in wood alcohol (or methanol). Methanol is highly toxic and presents serious technical problems when used as a motor fuel. But methanol can be made in large volumes from the nation's abundant reserves of coal, and Mobil has invented a way to transform it into high-octane gasoline. It is not cost competitive today (although it is much less costly than ethanol) but the relative economics could be more favorable in the future. The United States does need to reduce its foreign oil imports, and we believe our methanol conversion process can help achieve this objective in the future.

I trust this information has answered your question. Enclosed please find additional materials that may be helpful. We appreciate your interest and thank you for writing.

Sincerely,

MICHAEL GROSS,
Public Relations.

[From the Press, Atlantic City, Apr. 19, 1980]

OIL EXEC BLAMES NATION'S ENERGY WOES ON RULES

(By W. Leon Pope)

SEABROOK.—If America is to survive as an industrial nation it must free itself from dependence on foreign oil by developing more domestic oil and conserving energy, a Mobil Oil Company spokesman said here Friday.

However, federal and environmental regulations are hampering efforts by the oil industry to uncover new sources of energy, Robert A. Sailor of Mobil's Research and Development Corp. told nearly 100 social studies students at Cumberland Regional High School.

"Counter-productive laws and agencies helped create our energy problems in the first place," Sailor told the students gathered in the school's media center.

"We can't have our cake and eat it too," he said. "We have to have balance in some of the regulations that have been placed on us (the oil industry)."

According to Sailor, the government's energy policy for the next decade consists of conservation, synthetic fuel development and the "windfall profits" tax.

Describing the windfall tax as an "excise tax," Sailor said "The only windfall is the windfall the government is going to get.

"Of the money they're getting from the excise tax the government is only using 15 percent to find other energy alternatives," he said. "The rest goes into the general fund."

As for coal as a alternative source, Sailor said tough environmental laws have made it difficult to use.

"You can't mine it and you can't burn it," said Sailor, contending that environmental regulations are too strict.

Solar energy, Sailor said, is not the immediate answer to the nation's energy problems.

"Solar is a long way off," he said. "You're talking about two or three decades from now before solar will even begin to come into being (practically)."

"We're going to have to develop more and more domestic oil just to get through the next few years," Sailor continued.

During a question and answer period following his 15 minutes of remarks, Sailor defended Mobil's position against the recent government's allegation that the giant oil company overcharged its customers by $45 million.

According to Sailor, Mobil never overcharged its customers per se; it failed to follow certain federal guidelines.

Originally, he said, the federal government set prices oil companies could charge their customers on the average amount of profits on a yearly basis.

"Then the government changed it to the average over the quarter," Sailor said. "Obviously if we are found that legally we are wrong we will pay the money back to the public and whatever fines are imposed," he said.

As for nationalization of the oil industry, Sailor said, "I believe there are people in government who would like the idea."

"I hope we won't see it," he added. "I sincerely believe you won't see it in your lifetime."

Touching on another topic, Sailor said the government should allow oil from the Alaskan oil fields to be sold to Japan because it's too costly to ship it to refineries on the Gulf of Mexico coast.

If that were permitted, he said, American oil companies could then purchase oil from Mexico, which presently supplies Japan with most of its oil.

"Does it make sense to take our Alaskan oil and use energy to ship it to our refineries in the Gulf Coast?" he asked.

On gasohol, which is 10 percent grain alcohol and 90 percent gasoline, Sailor described it as a "myth" and not the solution to the nation's energy problems.

"It takes more energy to make than it's worth," he said.

The only reason some manufacturers are producing gasohol in America is because there are presently large surplus grain supplies in the nation.

Once those surplus grain supplies run out, Sailor said, it will be too costly to farmers to produce them solely as an energy source.

Gasohol, according to Sailor, is best suited for a country like Brazil, which because of its climate, can easily produce grain and sugar cane products that can be converted into grain alcohol.

[From the Philadelphia Inquirer, Feb. 22, 1980]

MOBIL'S PRESIDENT: FORGET ENERGY "PANACEAS"

(By David Diamond)

The United States should devote less efforts to "misplaced panaceas" for the energy problem—synthetic fuel, gasohol: solar energy and even "military options" in the Mideast—in favor of domestic development of oil, nuclear power and coal, the president of Mobil Oil Corp. said in Philadelphia yesterday.

Speaking to the Financial Analysis Federation at the Racquet Club, William P. Tavoulareas said that he preferred coal and nuclear power as alternatives to oil "because we already know all the troubles with coal and nuclear."

As for oil and gas development, he said: "Our country must stop subsidizing energy consumption through price controls. Instead, producers must have adequate incentive to explore for oil and gas in increasingly higher-risk, remote, expensive and often hostile areas."

He called the Carter administration's proposed windfall profits tax, now in a joint House Senate committee, "not really a profit tax, (but) an excise tax." He also said he was "discovered" by antitrust laws that he said limited joint ventures among the oil companies for development of synthetic fuels.

A few hours before his speech, Mobil announced that tests on two wells off the coast of Newfoundland had shown that the area might contain hydrocarbon-bearing sands.

Mobil earned $2 billion in 1979, a 78 percent increase over 1978. The earnings represented a 22.6 percent return on shareholder's equity—the highest among the major U.S. oil producers.

[From the Oil Daily, June 12, 1980]

HOUSE PANEL MAY EXAMINE DOE'S REPORT ON GASOHOL

WASHINGTON.—A controversial Department of Energy study on gasohol could be the subject of congressional hearings this month.

The Energy and Water Subcommittee of the House Appropriations Committee may ask Energy Secretary Charles Duncan about a report by DOE's Gasohol Study Group which backed coal-to-methanol conversion over alcohol fuels as a future energy source.

Critics of the report have noted that David Pimentel, the study group's chairman, has served as a paid consultant to Mobil Oil Corp., which has developed a process to convert coal to methanol, and Mobil research and development executive Paul Weiss was a member of the group.

E. Steven Potts, acing director of DOE's Office of Alcohol Fuels, was reported by the Washington Post this week to have advised Duncan in a memo to publicly repudiate the gasohol report.

The Post said Potts charged in the memo that a majority of the participants in the gasohol study were gasohol "antagonists" and that only one member, University of Nebraska Professor William Scheller, spoke for the alcohol fuels industry.

Scheller told a meeting of the Congressional Alcohol Fuels Caucus Monday that the alcohol study group:

Changed a draft report on alcohol fuel economics to eliminate any consideration of an animal feed byproduct resulting from alcohol production, thus making alcohol production appear uneconomic.

Disregarded favorable information on gasohol performance and economy.

Supported coal-to-methanol conversion with a thermal efficiency of 38 percent while criticizing energy use in alcohol fuel production despite evidence of a positive energy balance.

Rep. Tom Daschle, D-S.D., the caucus chairman, said that Scheller's testimony "put the nail in the coffin of the Energy Department's so-called gasohol study."

He said the study was a "sham," and charged that "the panel that prepared the study showed its true colors when it told Dr. Scheller, the only alcohol fuels expert on the panel, that it had lost his recommendations and did not care to receive another copy of them."

Daschle said, "I have no doubt that this report's conclusions were written first and the 'facts' were selected to support these predetermined conclusions."

Daschle said he has asked the General Accounting Office to investigate the Gasohol Study Group and the DOE's Energy Research Advisory Board, which convened the gasohol study committee.

[From the New York Times, June 19, 1980 and the Washington Post, June 22, 1980]

Science and Politics Don't Mix

Scientists don't live—or work—in ivory towers. Some toil in government labs; others may work at universities, or foundations, or in labs supported by private-sector corporations. Most believe and espouse what scientific evidence convinces them is true. And their conclusions shouldn't be colored by political considerations.

In fact, nothing turns science to mush faster than politicking. Just ask any geneticist what he thinks of Lysenko's theories, which became the official line in the Soviet Union some years ago.

Unfortunately, science seems to be coming under increased political pressure in this country. Recently, we were drawn into one such situation—the assault on a group of seven scientists assembled by the Department of Energy to study the potential of gasohol, a mixture of 90 percent unleaded gasoline and 10 percent grain alcohol. Gasohol is being billed as a means for reducing America's dependence on imported petroleum. On the other hand; many experts point out that it takes about 15 times as much fuel to grow, transport, and distill grain as is produced in the form of alcohol. Consequently, the wide use of gasohol would not reduce, and might even increase, the need for foreign oil and gas.

Briefly, the study group's report to the department's Energy Research Advisory Board weighed conflicting views and reached the following carefully phrased conclusions:

"Most U.S. fermentation/distillery plants producing ethanol are fueled by oil and gas and, therefore, are not providing the Nation with any new net high-grade fuel."

If all distilleries the study group thinks will be operating by 1985 were to run on fuels other than oil and gas, the total amount of ethanol they would produce would displace "less than 1 percent of U.S. gasoline consumption."

"Gasohol production, stimulated by high subsidies, will reduce the amount of grain available for meat, milk, and egg production." The taxpayers, of course, ultimately pay for these high government subsidies.

"Gasohol production will intensify environmental degradation . . . because of greater pressure for the use of land for grain production."

No sooner had the report been handed to the full Energy Research Advisory Board than a DOE functionary, who sat in on the study group's deliberations and offered no dissent, sent a scathing letter to Energy Secretary Charles W. Duncan, Jr. The letter, which was leaked to the press, attacked the report as having been bludgeoned out of the seven scientists by two of their number with ties to Mobil.

Specifically, the letter attacked Dr. Paul Weisz, manager of Mobil Research and Development Corporation's Central Research Division, an honored scientist with impeccable credentials, who is neither a proponent nor opponent of gasohol. He was asked by the department's then undersecretary for research to join the study group. The other victim was the chairman of the group, a professor at Cornell University and a world-renowned expert in agricultural sciences. His only tie to Mobil was a four-and-a-half-day consulting stint on agricultural sicence matters. Suffice it to say that Secretary Duncan sent a memo affirming his confidence in the study group's work.

But the fallout of this attack on the scientific community continues to spread. Barry Commoner, the environmental activist who is running for President, somehow managed to obtain a draft copy of the report even before the full advisory board saw it. He was ready with a printed rebuttal on the very day the panel's report was handed to the board. Jack Anderson, the syndicated columnist turned "energy expert," made the episode a cause célebre. This column, in turn, triggered a diatribe against Mobil in the Sioux Falls, South Dakota, Argus Leader.

And now, in the latest development, Senator George McGovern, in quest of reelection in grain-growing South Dakota, has taken the scientists to task. He has scheduled a hearing next Wednesday of the Senate Subcommittee on Energy of the Joint Economic Committee. Judging from the advance list of witnesses, which includes Mr. Commoner, the hearing can be expected to continue the political attack on Mobil, in fact, Senator McGovern's avowed reason for the probe, is to find out whether scientists, "with ties to Mobil Oil . . . would rob hundreds of thousands of American farmers" of the opportunity to benefit from gasohol development.

This is sheer nonsense. While Mobil does not produce or market gasohol, Mobil dealers are free to obtain and sell it.

Attacks on the integrity of private-sector scientists offer politicians ready-made dragons to slay, and provide publicity-seeking columnists with "exposés" to build circulation. But they also produce a chilling effect on the reporting of scientific findings. And they discourage university and business scientists from participating on panels of this sort, thereby leaving judgment in this area to dreamers and advocates of popular causes. Faced with the hazard of having their reputations besmirched, how many serious scientists would remain willing for long to lend their knowledge and talents to America's hunt for realistic energy alternatives? Who could blame them for backing off? And can the country afford such a self-imposed "brain drain"?

The answers are obvious. Clearly, science and politics don't mix.

Senator McGovern. Thank you very much, Mr. Campbell, for an excellent statement and for the effort you have made on this over the years.

Our final panel witness is Mr. Al Mavis who's the executive director of Agri Stills of Springfield, Ill. Mr. Mavis, we are happy to welcome you back to this committee.

STATEMENT OF ALVIN M. MAVIS, EXECUTIVE DIRECTOR, AGRI STILLS OF AMERICA, SPRINGFIELD, ILL.

Mr. Mavis. Thank you, Senator.

I come from a somewhat different position than the other panelists because I do sell and distill agriculture alcohol, and I think the things that have come out have been pretty much the things I have said.

I submitted two papers for you because I think they are self-explanatory except to bring up the fact that in the protein and food and fuel situation. In our type of plants we are talking about for every pound of alcohol we make we make a pound of high protein feed, not just livestock feed as so often is reported, but one of the major food processors in America has been analyzing that product. We leave all the oils and the dead yeast in and proteins turn out to be more than out of corn and have all the amino acids because the yeast is full of the two things that corn is short of. So we end up with a very, very viable potential human food product.

That brings me around to the economics of the embargo and I complimented the President when he embargoed grain to Russia and I'm a farmer. We could have given $1 billion worth of protein away, Senator, and improved a lot of the world food situation and had $1 billion more in ethanol for fuel than we had in total dollars had we sold the product.

So now to talk about the second paper where I think we must in America make enough agricultural alcohol available now before we end up going to war in the Middle East. We've got to have liquid fuel and the world is going to continue to be fed as it has been. If we are going to continue to live as we have, we must have liquid fuel.

As a vice president of the National Gasohol Commission, I'm privileged to get some information that may not be public. This happens to be an in-house report from Archer Daniels Midland and I want to make a few statements.

It said one of the favorable benefits of the alcohol program is it will put $1.8 billion into the balance of payments. The exports alone of the byproducts exceed $250 billion and will save some $120 million worth of foreign oil. This next year, by 1981, ADM's plants will produce 270 million gallons of ethanol from their three plants, more than half of what the President expects to get out of the complete country. When we add that together and look at what we are doing in Illinois where we can take a plant that costs basically $1 a gallon and produce every day 1,000 gallons of liquid fuel out of 400 bushels of grain and produce 10 tons of feeds—America has got to take a look at where we are.

The reason we are so concerned about the economics, the farmers are making so little return on such things as wheat in your country and corn in ours, they have swung to soybeans and sunflowers and a lot of exotics, and the eroding factor is that they are making so little profit in their farming operation—they farm land that is marginal. They are farming because they've got to pay the note at the bank, not because they don't know better.

When I look at the Wall Street Journal article by Mobil and it said scientists and politicians don't mix, I say they do mix or we wouldn't be here today. If the scientists had been really honest in the report the testimony would not have been like it has been today, somewhat incriminating. We are going to have all the ethanol and methanol, and we take methanol and use it very successfully in denaturing and blending with our ethanol to make a very supreme fuel. I drive a car on 100 percent alcohol. It can be done and it can be done economically.

When I begin to look at some of the other things mentioned here, I tried to find out if Mr. Pimentel or Mr. Weisz had ever visited the alcohol production facilities in the Midwest and as near as I can find out they have never had that occasion. So they alone have not much background on which to go.

Yesterday we had a full day program in Springfield, Ill., and it was closed by Mr. Templemeier of SIU and he was talking about a thing called ETHaCOAL. ETHaCOAL is a mix where you produce a new liquid fuel from coal and ethanol that has all the appearances of meeting the environmental standards. If we had the $10 million that the taxpayers sent to West Germany to work on the Mobil process we could have a pilot plant in operation and successfully test it before 1981 at SIU. So I'd like to ask you as a Congressman and Senator to fund some of those taxpayers funds our way.

With that, my testimony stands and I will take questions later in the day. Thank you.

[The prepared statement of Mr. Mavis, together with additional material for the hearing record, follows:]

PREPARED STATEMENT OF ALVIN M. MAVIS

Protein, Food and Feed of Ethanol Plants—Its Production, Marketing, and Economics

It will be a difficult period for the new and emerging fuel ethanol technology to reverse and correct the misinformation that exists with respect to the enriched coproducts produced in fuel ethanol systems be they large or small.

Perhaps it is best to study the basic situations that prevail in any ag ethanol production plant where cereal grains are used as a raw source. The same valuable products do not exist where the raw source is from cellulosic material or from waste streams such as cheese whey, wood sugar, damaged cookies, cull potatoes, potatoe waste and etc.

The ethanol production plant, be it a farm still, a community fuel ethanol production plant or a large distillery, produces one pound of high quality protein and oil, food or feed each time it produces one pound of fuel ethanol. In broader terms, a bushel of most cereal grains contain 16–18 pounds of fuel ethanol, 16–18 pounds of food or feed, and 16–18 pounds of carbon dioxide. A farm still that produces 30 gallons (approximately 200 pounds) of ethanol for fuel consumes 12 bushels of grain but also produces 200 pounds of food or feed that is high in protein, oil and minerals.

Many editors, church leaders and particularly World Watch Institute writes "Food or Fuel"—There is abosolutely no possibility. Ethanol can only be produced from carbon, hydrogen, and oxygen leaving behind all the nitrogen, phophorous, potash, minerals, and trace elements. A speech assignment that is to address the problem of production and marketability of the product produced in conjunction with fuel ethanol is in direct conflict with the "Food or Fuel" concept. Further, it is just as incorrect, in fact, as is the supposed creation of a food shortage by the conversion of some of America's and the world's surplus starch and sugar into liquid fuel. The true concept should be food and fuel.

The Illinois program that started in November, 1977 was based on ethanol made from a cheese whey plant in Juneau, Wisconsin. The introduction of fuel ethanol by Archer Daniels Midland of Decatur did not see a new plant or a new industry, quite the opposite. The ag ethanol production system was added to and became a part of the ADM food ingredient production system. Secondly, the whole of the world and particularly the United States are long starch sources. Every nation, including the third developing countries have ample supplies of starch but lack protein and oils that are in a consumable state. For a few examples of how this is true you must look to Sweden that sell 1½ million metric tons of excess starch crops into the world market at an economic cost in dollars, product and fuel value, that exceed 600 million dollars. Austria, that heavily subsidizes its excess wheat sales to Poland. The European economic community that has a tariff of more than $3.00 per bushel of U.S. corn yet the protein and oil from corn can

enter the EEC tariff free. What of the starving of India—selling wheat and importing protein and oil? Developing nations lack fuel, high quality food, and a market. The third developing nations whose agricultural segment are peasants, who import all their oil, farm with hand and horse labor yet have surplus starch. When and if this starch were converted to ethanol it would furnish the fuel for power machinery to cultivate more acres and would furnish these nations high quality food and feed for their people and animals.

Fourth, America's agricultural profits are so low, particularly on starch and sugar crops like corn, wheat, barley, milo, and sugarbeets that farmers have changed rotations and are changing crops and in many parts of the corn belt are overplanting soybeans. If and when a profitable market for U.S. starch production is available from the new alcohol market, the American farmer will return to rotations which in turn will reduce overplantings of soybeans, and stop them from switching to sunflowers and other exotic crops.

Fifth, the extremely low return in agriculture accompanied by high farm expense and heavy debt has forced the farmer to place in cultivation increased acreage of marginal land subject to serious land and water erosion. Until such time as the farmer can get enough dollars to operate and pay debts he will continue to farm marginal, erodeable land.

With this background let us look for a few moments at the economics of fully refining our AG production before export. I'll cite as the first example, Archer Daniels Midland story in Prairie Farmer, April 5, 1980. Here lies the real story—A bushel of Illinois corn converted to fuel ethanol has less than $2 oil and protein and more than $4 liquid fuel. Market students and analysts have always known that the oil and protein is worth about ⅔ the cash market value of the corn. The problem has always been to find a viable, profitable, suitable market for the starch. This simply means if and when corn gets to $4 the most to be expected from the oil and protein is about $3. For all these many years the oil and protein have been the main product. Now that alcohol is a profitable, viable product everyone wants to call the oil and protein a by-product. This certainly is not the case—At the most it might well be classed as a co-product.

If America really wants to be the great humanitarian Nation all our politicians claim, we in America now have a real opportunity to do so. An example might well be the embargoed Russian grain sale. Here a 2.25 billion dollar sale completely upset normal markets, the Board of Trade and much of Agriculture. Yet, we could refind this product, give the so-called starving world 300 million pounds of high quality protein food and have fuel that is worth one billion dollars more than it was sold for and have the ability to replace more than 1.7 billion dollars worth of high priced, non-renewable, OPEC petroleum with 1.7 billion gallons of clean burning, renewable, AG ethanol.

In a Nation that is in depression, has a high unemployment, is sending its capital assets overseas to buy oil, and is continuing to write and talk of those who starve, let us but for one moment look at the U.S. export corn. One doesn't have to look at surpluses, carry overs or the farmer reserve but just look at the corn we sell at depression prices so as to try to shore up our foreign exchange. In these last three years we have exported more than 2 billion bushels and this year look for 2.3 billion or more. This corn will sell for less than 6 billion dollars. What a disgrace it is for us, the humanitarian nation to dump into the starch loaded world our starch and then to vie with the world over liquid fuel and bring on the escalation of prices to the point the developing nations cannot afford fuel for their farms. Quite the opposite could be the case if America would first refine this corn into fuel ethanol, food and feed and carbon dioxide. These 2 billion bushels contains 5 billion gallons of ethanol worth more than 9 billion dollars.

This fuel alone is worth more than 1½ times the full sale value of the corn. It contains thousands of new jobs, will lead to a cleaner environment, and will replace almost 5 billion gallons of OPEC oil costing more than 4 billion dollars. This all sounds great but the big nail needed to close the case is the 40 billion pounds of high quality protein we could give the starving of the world. This protein has a market value of more than 3½ billion dollars. Because a pound of this high quality protein is one of the so-called bypass proteins it will result in faster and cheaper feed grains which in turn will assure the livestock feeder a profit so he can stay in business and both offer a market for the protein as well as food for the consumer.

In the case of dairy cattle these new proteins both increase milk and butter fat production offering more for the consumer. Further it has been demonstrated

that young heifers being fed this feed can be brought into production in 24 instead of 30 months. This again offers more production for the consumer.

Excessive amounts of cheap starch feeds have always resulted in less profitable feeding operations and in most cases less units of edible product. Cheap, surplus starch usually is paralled by a slow down in protein use and when protein becomes scarce and high it is also fed at a slow rate. If America and the World are to have the best in foods and feed we must develop this program that will eliminate surpluses of starchy food and feed and peaks of over-priced and scarce protein.

My prediction is that with the advent of the food/feed co-product of AG ethanol production, America and the World will see higher and more stable prices, a reduced soybean acreage because of enough profit in corn so a farmer can rotate, a lessening of erosion problems as the farmer is paid enough for his production so as to eliminate the cultivation of marginal lands and an easing of world tension as America, Sweden, England, Brazil, Austria and the balance of the world develop an alternate fuel source from agricultural production.

AGRI STILLS OF AMERICA,
Springfield, Ill.

EMBARGO ECONOMICS

After these many days the U.S. grain markets have not recovered from the sharply lower prices that occurred following President Carter's announcement that he would embargo further shipments of America's cheap grain to Russia. This was to indicate America's disapproval of Russia's continued encroachment on the people and lands of the Middle East.

Many of you were angry over the President's reversal on grain embargoes. Perhaps some of you even wrote or wired the White House and your congressional leaders of your feelings. If you were one of those, I'd like to suggest you take another look and see if the decision would be the same if you look at it in light of the true economic value of the sale. I'm certain we all agree that selling anything to any of our enemies should be a complete No-No.

Historically a guaranteed profit has been low due to the cheap selling price of our ag production. This Russian sale was no exception. Here again the American farmer sold his raw products to the grain exporters at prices below cost of production.

13 million metric tons of corn and 4 million metric tons of wheat—a total of 17 million metric tons is reported to have been sold for 2.25 billion dollars. Please keep in mind this is the sale price, not the price the farmers received for their production. This was a bad sale and will produce some space for new production but will not in any way assure farmers any semblance of financial success.

The President at this same time announced a major move to convert U.S. farm production to fuel ethanol. This is an absolute must both for agriculture, for America and the World. Every segment is faced with a shortage of liquid fuels that are overpriced and are controlled by a handful of camel jockey and seven oil companies.

The announcement of the cancellation of this 2.25 million dollar sale wrought havoc to the commodity markets and brought on a decline in prices. There would have been none of this if during the past two years the USDA, DOE, and our Congressional leaders had done their part in implementing a full blown liquid alternate energy program for renewable ag ethanol. Having agreed to all this let us look at the economics of selling or not selling:

These 17 million metric tons contain:

	Billions
1.7 billion gallons of fuel ethanol at the current wholesale price at $2.02	3.4
1.4 billion pounds of protein and oil for man or beast at 0.07 plus	1.0
1.7 billion gallons of foreign gasoline not required at $1	1.7
Total true value of embargoed 17 million metric tons	6.1
Sale price to our enemy Russia	2.25
New dollar value of embargoed grain when the American farmer gets off his duff and accepts his new role as a fuel producer	3.85

AGRI STILLS OF AMERICA,
Springfield, Ill., July 3, 1980.

Senator GEORGE MCGOVERN,
Joint Economic Committee, Congress of United States,
Washington, D.C.

DEAR SENATOR: Thanks for your leadership in pointing out to America some of the problems with DOE, big oil and renewable fuel ethanol from agriculture. Mobil's heavy hand appears quite often. I write this letter to substantiate my oral testimony at the June 25th meeting of the committee and ask this be entered into the record along with my written presentation. None of the ERAB committee were really agricultural experts and none that I can ascertain ever produced one gallon of commercial fu el ethanol, nor made a living operating a commercial farm.

What agricultural ethanol does is reverse the energy situation, where as burning of coal and oil reduce the mass to vapors the American farmer gathers the carbon, hydrogen and oxygen from the air and consolidates it as starch and sugar. Fuel ethanol plants then convert this to needed liquid fuel and high quality food and feed on a one for one basis. The Mobil ad in the Wall Street Journal contains many inaccuracies such as—"gasohol production stimulated by high subsidies." The 4 cent exemption as you know is not a subsidy but an incentive to the gasohol user by reducing pump price. As for reducing grain for livestock feed, our export corn contains more than 5 billion gallons of fuel ethanol. This does not take into consideration the bushels not produced because of Federally supported massive set aside programs, millions of bushels held in storage and grain reserves and the 17 million metric tons embargoed.

With respect to "greater pressure for the use of land" this has been brought by a severe economic situation associated with low agricultural prices. When corn prices get back to cost of production farmers will return to a rotation which will reduce current levels of erosions.

America is lucky that Barry Commoner had an early copy of the report and alerted us to this inaccurate study. Further I'm grateful to Jack Anderson for his reporting this.

Senator, you are to be congratulated on your support of the fuel alcohol program as a continuous, viable way to improve prices and markets for the grain growing state of South Dakota.

I hope this hearing will notify university and business scientists that the U.S. Congress and the American citizen consider one-sided reports improper and will not put up with such behavior.

With respect to, "How many serious scientists would remain willing for long to lend their knowledge and talents", I submit we don't need any more if their report is to be so one sided. It is far better we receive none of their advice if it is to be incorrect or partial.

In closing I repeat: "Science and Politics must mix."

Sincerely,

ALVIN M. MAVIS,
Executive Director.

Enclosure.

ILLINOIS ALCOHOL FUELS ASSOCIATION,
May 23, 1980.

E. STEVENS POTTS,
Acting Director, Office of Alcohol Fuels,
U.S. Department of Energy, Washington, D.C.

DEAR MR. POTTS: With due respect to the Energy Research Advisory Board and Mr. Solomon Buchsbaum, Chairman, and with full knowledge of their stated expertise, prominence and integrity, the Illinois Alcohol Fuels Association feels that the Energy Research Advisory Board (ERAB) Gasohol Study, April 29, 1980, contains many erroneous and detrimental statements about fuel-grade ethanol.

We understand that your office is preparing a report to Secretary Duncan responding to the findings of the ERAB Gasohol Study. We have taken this opportunity to prepare our responses to the study, hoping that they might be of help to your office's report, by presenting the perspective of current fuel-grade ethanol producers.

Initially, we would like to comment on Mr. Buchsbaum's introductory letter of the ERAB Gasohol Study to the Secretary of Energy, Charles Duncan, May

2, 1980. We are also enclosing a more thorough response to the findings, item by item.

The lack of understanding of fuel-grade ethanol issues is evident in the principal conclusions stated by Mr. Buchsbaum in the introductory letter.

In the first conclusion, Mr. Buchsbaum cites a 200–300 million gallon per year annual goal of production for 1985 and an 800 million gallon per year annual goal thereafter as reachable goals. From indications in current production and construction plans, the 200–300 million gallon volume will be reached by 1981. The estimate of 800 million gallons yearly after 1985 indicates that there has been no thought given to a steady increase of the building and operating of ethanol plants in the future. We cannot fathom that the ethanol industry will not see the expansion that any new industry has seen, when it possesses the potential of asserting America's independence in the energy field, which is of critical importance to our country. History has proven that American ingenuity flourishes when a solution to a critical problem comes within its grasp.

The policy developed by the Department of Energy for fuel-grade ethanol will be a significant determinant in the production possibilities for 1985. Public perception of ethanol can be greatly affected by the conclusions that the DOE makes about ethanol as an alternative liquid fuel source. A negative conclusion about fuel-grade ethanol as an alternative could inhibit potential producers from entering the industry. Whereas a positive conclusion that ethanol is a viable major source of alternative fuel could be responsible for wide public acceptance and stimulate interested parties into the fuel-grade ethanol industry.

In response to the second conclusion from the ERAB Gasohol Study on the subject of the net energy balance in ethanol production, current technology in the fuel-grade ethanol production is showing a net gain in energy exchanged when producing a gallon of high-grade ethanol. American ingenuity continues to contribute new and energy efficient technology in the fermentation and distillation processes.

Mr. Buchsbaum states that conclusions and recommendations were based on the best available data but no reference of information from a current fuel-grade ethanol plant is cited throughout the report. We feel that despite any time constraints placed on the ERAB Gasohol Study Group, all perspectives of an issue as important as petroleum alternatives should have been investigated. We feel this was not the case in the ERAB Gasohol Study because it neglected to include the vital input of fuel-grade ethanol producers. Mr. Buchsbaum also notes that the final draft was a result of clarifying some points in the original draft. We feel that ambiguity in many of the findings still exists and more facts are needed.

We, the Illinois Alcohol Fuels Association, do not feel that adequate attention was given to all the facts when evaluating whether fuel-grade ethanol is a potential answer to the serious problems that now exist in this country, as we feel it could be:

The gasohol issue will continue to flounder as a result of reports from recognized groups which don't adequately address the facts from all perspectives.

If at any time Secretary Duncan decides to reconvene the ERAB Gasohol Study Group, the Illinois Alcohol Fuels Association would like to offer its service and expertise in the formulation of a report that evaluates high-grade ethanol as an alternative fuel source. We are a group of actual and potential fuel-grade ethanol producers and could provide the current facts as each day brings on new and significant breakthroughs in the production of raw material and their conversion into a high quality fuel.

Sincerely,

ALVIN M. MAVIS,
Vice President.

Enclosures.

The findings of the Energy Research Advisory Board are presented directly as published in the Gasohol Study. The responses of the Illinois Alcohol Fuels Association follow each of the items to which we were able to respond. There are some aspects of the Gasohol Study which we feel can be answered more comprehensively by others in the alcohol fuels field. For that reason, we defer those to the Center for the Biology of Natural Systems and the Solar Energy Research Institute, which also responded to the ERAB Gasohol Study.

The Illinois Alcohol Fuels Association hopes that our additional comments will shed more light on the issues of fuel-grade ethanol and that as producers we will be able to offer our perspective as people who deal with issues daily in a very practical sense.

GASOHOL ENERGETICS AND ECONOMICS

1. Using either existing technology or the best available technology before 1985 with existing oil- or gas-fueled fermentation/distillation plants, the net energy return for ethanol production from corn and other crops is about zero. If fermentation/distillation plants were fueled by coal, then each gallon of ethanol produced could save roughly 0.5 gallons of oil.

Response. The leading producers of fuel-grade ethanol in the country today, both large scale and community size, are showing a net energy gain of at least two-to-one from their natural gas or propane fueled fermentation/distillation plants.

Jim Randall, President of the top producer of fuel-grade ethanol, Archer, Daniels Midland Company in Decatur, Illinois spoke about the net energy balance.

"There is no question of a very positive energy return in fuel ethanol production at ADM. We are producing fuel ethanol at a net energy gain and we are not prepared to release this proprietary information because a release of this would be beneficial to our competitors. In fact, it is foolish to dwell on the energy balance question or the food versus fuel issue when you look at the ethanol and co-products we are selling on the market today.

"Our energy gain is increasing daily as we discover new and more efficient technologies. We are lowering energy consumption through the continuous fermentation process, mechanical recompression for evaporation and improved distillation technology. The figures of the ERAB report must have been based on the liquor distilleries or old World War II alcohol plants. We are one of the three major producers making fuel alcohol today and we were not asked about our energy inputs and outputs.

"Fuel ethanol is definitely going to have a significant impact on the energy situation, whether it's from grain, starch and sugar crops or cellulose. We are developing low energy consuming processes for fermentation and distillation which are processes that could be used in producing all types of alcohol. We feel that ethanol from grain is the best way to produce liquid fuel. We are producing it today. It's fine to set goals for developing alcohols from other feedstocks but they aren't going to be on line producing, energetically and economically, for at least five years, from what we can see and we have got to give the people of the country part of the energy solution today."

Al Mavis, Executive Director of Agristills of America, Springfield, Illinois, has a community size, modular plant. "Our current production is quite efficient. We try different technologies everyday to find more ways of cutting energy consumption. But there's no doubt about it, we are gaining 30,000 or more thermal BTUs of energy every time we make a gallon of high-grade ethanol."

2. In the 1985 time period, total ethanol production using grains and non-oil/gas-fired distilleries could have significant effects in certain regions, but a limited impact on total U.S. oil consumption. Production of ethanol could reach 800 million gal/yr. If utilized in producing gasohol, 20% of the current national unleaded gasoline requirement could be blended to gasohol. This would displace an equivalent of 26,000 bbls of oil per day or less than 1 percent of U.S. gasoline consumption.

Response. Total ethanol production using grain from both oil- or gas-fueled and non-oil or gas-fueled distilleries will reach the 800 million gallon/year goal long before 1985. This is based on current production figures of fuel-grade ethanol producers and future projections.

Archer, Daniels Midland Company, ADM, in Decatur, Illinois currently has the capacity to produce 150 million gallons. A second plant with comparable production capacity is being constructed presently in Cedar Rapids, Iowa. These two plants alone will be producing 300 million gallons by 1981. In addition, ADM has acquired the Hiram-Walker distillery in Peoria, Illinois and will convert it to fuel-grade ethanol production.

There is no way to calculate the amount of ethanol which small scale plants will contribute to the future total projection. A conservative figure, based on a mearger estimate of twenty 50,000 gallon/year plants per state, would add an additional 50 million gallons of ethanol to the total.

3. Most U.S. fermentation/distillation plants producing ethanol are fueled by oil and gas and, therefore, are not providing the nation with any new net high-grade fuel.

Response. Two leading major producers of fuel-grade ethanol, Archer, Daniels Midland Company in Decatur, Illinois and Mid-West Solvents in Atchinson,

Kansas, are using natural gas to fuel their plants. According to Cloud Cray, President, Mid-West Solvents, their distillery is fueled with natural gas. "We have maintained a supply of No. 6 crude oil for standby measures, but we haven't touched oil in eighteen months in our plant," Mr. Cray explained.

When looking at natural gas or propane use to make ethanol, a "new net high-grade fuel" is being made. Ethanol is a superior high-grade fuel compared to natural gas or propane, which cannot be used to fuel cars directly.

Fuel-grade ethanol from oil- or gas-fired distilleries should be considered as a viable liquid fuel alternative and a factor of consequence in setting the goal for future ethanol production because current legislation on fuel-grade ethanol production includes this source of fuel for production until 1982.

4. Additional gasohol benefits in the petroleum refinery operation and for the mileage performance of gasohol are currently subjects of controversy. Adequate testing is needed, with further assessments of gasohol taking into account the state of future technology both in automotive engines as well as petroleum refining.

Response. The Illinois Bell Telephone Company recently publicized its findings, based on a twelve month study of gasohol (April 29, 1980). According to this study, the thirty cars monitored in this test showed an average of a 4.8 percent increase in mileage results. Ron Aldridge, the company's division manager for automotive operations, said the trial indicated that usage of the cleaner burning fuel could lead to savings in maintenance costs through longer engine life and could mean a reduction in the number of tune-ups required to keep vehicles operating efficiently. Illinois Bell will expand its use of gasohol in its fleet.

5. The cost of corn constitutes about 73 percent of the manufacturing cost of ethanol; hence, process research directed to other areas of cost reduction will have little impact.

Response. This is simply incorrect, because the study fails to apply actual current data. Consequently, the conclusions are inaccurate and based on outdated figures.

The co-products from a wet milling operation are worth $1.88 according to market value of each as quoted by Archer, Daniels Midland Company (May 27, 1980):

COMPARATIVE RETURNS PER BUSHEL OF CORN TO WET CORN MILLERS

Product (per bushel)	Market value (per pound)	Return of corn
1.7 lb of corn oil	$0.235	$0.40
3 lb of corn gluten meal	.107	.32
14.5 lb of corn gluten feed	.049	.71
15 lb of CO_2	.03	.45
Base value of products from a bushel of corn		1.88

The present market value of corn is $2.60/bushel (May 27, 1980, Kansas City Board of Trade).

Bushel of corn	$2.60
Return value of co-products	1.88
Net carbohydrate cost	0.72

If the net cost of corn constitutes $0.72 per bushel or $0.29 per gallon of ethanol and this cost actually was 73 percent of cost, a gallon of ethanol would theoretically cost $0.40/gal., 73/100x29/X then X=$0.40 or $.40 per gallon.

This figure is totally inaccurate by even the Gasohol Study's estimate.

Research directed to other areas of cost reduction will have an impact because corn cost is far less than 73 percent and there are many areas in which costs can be reduced.

6. The value of the by-product cattle feed (distillers' dark grains) could reduce the impact of the high material (corn) cost by as much as one half.

Response: From each bushel of corn (56 pounds per bushel), a wet corn milling/alcohol plant will produce the following products (average yields):

Provided by Archer, Daniels Midland Company.

Corn oil: 1.7 pounds, enough to make over 2 pounds of premium-quality corn oil margarine. Also used for salad oil and cooking oil.

Corn gluten meal: 3 pounds of Corn Gluten Meal, a 60 percent protein product in demand by the broiler and layer industries because of its ability to add pigmentation to egg yolks and frying chickens as well as for its high protein content.

Corn gluten feed: 14.5 pounds of Corn Gluten Feed, a 21 percent protein product widely used as a protein source in feed rations. Enough gluten proteins are produced from every bushel to provide the protein requirements for feeding over 6 market-weight (3 pounds dressed) frying chickens.

Corn starch: 31.5 pounds of starch are recovered which is converted to approximately 2.5 gallons of 200 proof ethanol.

Alcohol: Between 2.5 to 2.6 gallons of 200 proof ethanol can be produced from the starch component of one bushel of corn.

Carbon dioxide: 15 pounds of CO^2 will be produced by the fermentation of alcohol production. CO^2 is used to carbonate beverages and in the "Flash Freezing" of prepared meat, bakery and food items. There are also growing numbers of industrial applications for CO^2.

In addition to the above listed products, a further benefit can accrue from this process. We are developing a hydroponics operation using "waste heat" from the corn milling/alcohol plants heat as a heat source and the CO_2 generated from fermentation to accelerate plant growth and maturity. Such vegetables as lettuce, tomatoes and cucumbers would be produced on a year-round basis in northern locations close to large markets, by-passing the need to transport them from southern production areas. This would also be a further improvement for developing the favorable food/fuel cycle for the wet corn milling/alcohol process.

There is a good export market for the corn, gluten proteins, and corn oil. Naturally, the use of alcohol in gasohol can replace imported fuel. Therefore the operation of a wet corn milling/alcohol plant contributes to a favorable balance of payments. The use of fructose by the U.S. food and beverage industry can reduce the sugar imports now necessary to meet U.S. requirements. Thus domestic fructose production also improves the balance of payments situation. Based on current market conditions, ADM's fructose and alcohol operations (when current expansion is completed at the end of 1981) could contribute as much as $2.25 billion per year to a favorable trade balance.

7. Current tax incentives for ethanol production, especially state tax rebates, appear to be more than adequate to encourage investment today with existing technology.

Response. Guaranteed loans and low interest rates would be the best assistance the government could give to potential investors and producers.

8. Current federal and state tax incentives for ethanol production appear to have encouraged some ethanol from petroleum ethylene to be sold in the market place. The production of ethanol from ethylene that was produced from oil does not contribute to the nation's energy needs.

Response. The production of ethanol from ethylene, which is derived from petroleum, is not likely to be sold in the market place as a fuel. Ethanol from ethylene is worth more to the chemical industry for synthetic production than it is to the fuel market. It has less contaminants than fermented ethanol and brings a higher price in the industrial chemical market. The current value of ethanol, derived from ethylene, is $1.88/gal. for 190 proof and $2.02/gal. for 200 proof. Furthermore, present tax credits only apply to fermented ethanol as a fuel. (Union Carbide pricing of ethanol from ethylene).

9. The cost of high-grade fuel produced as grain ethanol with current best available technology should be greater than methanol produced from natural gas or coal with best available technology. Research on methanol production from coal is needed to fully investigate this potential.

Response. "So I think if you said tomorrow morning I want 100,000 barrels a day of synthetics, there is only one choice for than, you get some gasohol." John F. O'Leary, former deputy secretary, Department of Energy, during testimony before the House Banking, Finance, and Urban Affairs Committee, (May 15, 1979.)

The fact that fuel-grade ethanol is a product being produced, which today is economically, environmentally and energy efficient, is of major significance in the search for alternative fuel sources. It is important to investigate all potential sources for energy alternatives. But ethanol should become an alternative fuel which this country should develop because of the advantages of its renewable co-products and its superiority as a high-grade fuel.

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10. Research is needed on various agricultural systems that would allow for the production of food and some ethanol while protecting land productivity and environmental quality.

Response. Implementation of reduced tillage systems is needed so that these agricultural systems will continue to improve production while protecting land productivity and the environmental quality of water and air. It is evident that food production and ethanol production are of mutual benefit to the world. By producing ethanol, the farmer could see a return on his corn production investment and the enrichment of protein in feed.

11. Cellulosic biomass is more abundant and available than grain and other agricultural crops and could be a cheaper substrate for ethanol production; unfortunately because of research and development needs, ethanol from cellulose fermentation is not likely to be commercialized until after 1985.

Response. Cellulosic biomass is certainly a more abundant substrate than grain and will be a major source for ethanol when the technology comes on line. But agricultural cellulosic biomass should be excluded from ethanol production because it serves a better purpose environmentally by being left on the field in a mulch till, minimum tillage agricultural system. Several factors explain why agricultural cellulose should be left on the fields. These are explained in the Gasohol Study but seemingly disregarded in the summary of findings at the beginning of the report.

By removing the agricultural residue, the nutrients it provides would have to be replaced with commercial fertilizer. Expenses for the recovery and hauling of cellulosic biomass and replacement fertilizers are high in both economic and environmental costs. If crop residue is not returned to the land, a renewable part of the production cycle is being destroyed. It is time for our country to use methods that contribute to a renewable cycle rather than to use those which contribute to the depletion of resources.

GASOHOL IMPACT ON FOOD AND THE ENVIRONMENT

1. The advantage of ethanol production from cereal grains and other food crops is that it can provide a quick supply of liquid fuel during the 1980's. A small surplus of grain exists today for ethanol production (in part because of the Russian grain embargo) but there are uncertainties about future demands, especially in light of the world food problem.

Response. The advantages of ethanol production from cereal grains and other food crops are that it currently can provide a substantial supply of liquid fuel and produce a high-protein feed as a consequence. This high protein feed would be of benefit to the world food problem because the world's hungry are lacking in protein, not starch, and the ethanol production method converts starch to protein.

Secondly, the small surplus of grain, which resulted from the Russian grain embargo 17 million metric tons, contains 1.7 billion potential gallons of ethanol. This is more than 15 percent of America's total gasoline consumption.

Senator MCGOVERN. Well, thank you very much, Mr. Mavis, for your statement. That bell that just rang is a rollcall in the Senate. I'm going to suggest that we recess for about 5 minutes. I will go vote and then come back and we will hear from Mr. Potts and Mr. Stelson at that time. Then after some brief statements by them we will have a brief period of questions and answers. I think we can come pretty close to winding this up a little after 12 o'clock. I'll be back within 5 minutes. I'll call a recess for that period.

[A short recess was taken.]

Senator MCGOVERN. We will resume the hearing with Thomas Stelson who is an Assistant Secretary of the Department of Energy and former member of the gasohol study group, and then we will hear from Mr. E. Stevens Potts, former Acting Director of the Office of Alcohol Fuels of the Department of Energy. I think we'll begin with you, Mr. Stelson. With our time bind, if you could hold your statement to about 10 minutes we would appreciate it.

STATEMENT OF THOMAS E. STELSON, ASSISTANT SECRETARY FOR CONSERVATION AND SOLAR ENERGY, DEPARTMENT OF ENERGY

Mr. STELSON. Thank you, Senator McGovern. I will submit my prepared statement for the record.

Senator MCGOVERN. The full prepared statement will be included in the printed record.

Mr. STELSON. It's a pleasure for me to be here today to discuss the Energy Research Advisory Board report, to discuss the progress in the development of alcohol fuels, and the DOE activities related to that development and, in general, to the future development of alcohol.

First: I'd like to review the nature of the advisory committee to the Department of Energy. When DOE was created in 1977, it acquired a number of advisory committees, none of which were able to satisfy the broad needs of the Department. ERAB was established to provide long-range guidance and needed advice.

It operates in compliance with the Federal Advisory Committee Act. ERAB subcommittees are selected based on experience, preeminence in a particular field, and other criteria, and report to the full committee. ERAB regularly appoints these study groups affording more specific knowledge and greater technical expertise on certain issues. Study groups are not advisory to DOE. Rather, they present their findings to ERAB. This is the typical process and this was the process used by the gasohol study group.

The gasohol review was initiated at a public ERAB meeting last fall by the then Under Secretary, Dr. John Deutsch. The ERAB chairman requested Dr. David Pimentel of Cornell University and a member of ERAB, to lead the study group. He is a resident expert on agricultural sciences.

Members of the study group were selected by the ERAB chairman. They had diverse backgrounds. Dr. Scheller, who testified earlier here, was a member and I was as well. My own experience is wide and varied. I organized a group of engineers and scientists who went to Brazil and helped there with the development of the alcohol program. Many consider that one of the outstanding programs in the world. In my administrative capacity at Georgia Tech prior to coming to DOE, I built up a very strong alcohol fuels group working in all areas of alcohol fuels development, and I'm proud of that background.

To the best of my knowledge, no other members of ERAB had prior involvement in alcohol production.

The first study group meeting was in Washington on December 10 and 11, 1979. Minutes and a transcript of the second day have been made available to the public.

I would like to share with the committee the text of a letter that Secretary Duncan sent to Congresswoman Smith: "The ERAB report will be considered as any other piece of advice to the Department of Energy. Advisers do not make policy."

I would now like to turn to the findings of the gasohol study group. The study group findings are a broad overview of the multi-faceted alcohol issue. The issue of small-scale, on-farm production also is addressed, but not at length due to the lack of technical data at that time. The ERAB biomass panel in operation now is addressing that aspect.

ERAB recommendations should be considered in the context of reducing foreign oil imports and I would point out it was a research advisory group. It did not advise on how to develop an alcohol fuels program in the United States.

Furthermore, I would comment that in December 1979, conditions were quite different than they are today and many of the improvements are due to the positive aspects of the gasohol study group. They found that a large state and U.S. Government program of economic support currently existed and that production is expanding.

They found that production technology is mature. This is an important finding because they did not recommend an extensive research program in ethanol which would have delayed development.

They found that much of the ethanol produced in oil or gas fired facilities may not contribute net new high grade fuel and that was a significant question.

They also found that if facilities for production of ethanol from grain were coal-fired or used other sources of energy, significant new net high grade fuel could be produced and the imports could be reduced.

In summary, the report is a positive statement on behalf of alcohol fuel development and to the best of my knowledge it has not adversely affected our commitment to and our aggressive program for developing alcohol fuels in the Department of Energy.

At this time I would like to review some of those key recent accomplishments.

The Office of Alcohol Fuels went into operation within 7 days of its establishment. The office has assessed and redirected previously funded activities. A much needed alcohol fuels information collection, analysis and dissemination activity has been established and is operating effectively. Management and control procedures are in place for the new Senate bill 932 when it is signed into law. DOE is working closely with the Department of Agriculture to make sure that the implementation of the Senate bill 932 provisions are rapid and effective. We have transferred $3.8 million to USDA for a study of feedstock research and the placement of small stills on farms. DOE is working closely with the Departments of Commerce and Education, with HEW, EPA, the Small Business Administration, and others on the effective development of alcohol fuels.

We have funded the initial cost of a technical assistance service at the Idaho National Engineering Laboratory. This will be available to other Federal agencies as well as to DOE for technical assistance in alcohol fuels.

We are further in the process of establishing an outstanding alcohol fuels laboratory at the Solar Energy Research Institute in Golden, Colo.

The Office of Alcohol Fuels handles a tremendous public information flow of about 400 telephone calls per day. The DOE Office of Hearings and Appeals has expedited hearings on a locations for alcohol fuel producers and blenders. We have proposed new regulations to speed up our allocation processes even further. Public hearings will be held soon.

Nearly 1,000 proposals for feasibility studies were received under Public Law 96–126, the Alternate Fuels Act; 60 percent of these were

for the production of alcohol. They are now in the review process and it is anticipated that the start of awards will be made before the end of this month.

DOE has started on our plan for the implementation of the Energy Security Act. We have drafted loan guarantee regulations. We have prepared all the necessary forms and applications and agreements. Initial meetings with USDA have been held. An experienced technical staff is now in place for proposal evaluation and review. One-day conferences are planned at six major financial centers around the country to brief the financial community on the program's investment advantages.

We are also working on a number of activities at DOE that are not in place at this time. One of the most critical is cellulosic conversion. As was mentioned here earlier today, cellulosic conversion has enormous potential for large amounts of low-cost ethanol production. We have directed SERI to bring together the foremost authorities in cellulosic conversion to determine the processes which appear to present the greatest opportunity for success. Based on their findings, we would consider initiating a research program with a goal of accelerating the introduction of commercial-scale production of alcohol from cellulose.

We have taken a series of steps and are studying the constraints and barriers to alcohol fuel production and marketing. Federal and State regulations are inequitable in some cases with respect to transportation tariffs, and we are trying to correct that.

We are also taking strong steps with respect to consumer protection. We are designing a consumer information program and we plan to have an alcohol fuels lab at the Solar Energy Research Institute to react to public complaints and lack of information.

In conclusion, the alcohol fuels program has an aggressive, positive future. DOE is working diligently to make sure that the significant technical developments are here when needed and that the public is well served by the programs that we have.

Senator McGovern. I thank you very much.

[The prepared statement by Mr. Stelson follows:]

PREPARED STATEMENT OF THOMAS E. STELSON

Mr. Chairman and members of the committee, it is a pleasure to be with you today to discuss the gasohol report developed by the Energy Research Advisory Board (ERAB), review the progress we have made in the development of alcohol fuels and share with you our thoughts on the future potential of this important near-term energy source.

Before I discuss the information developed by the Gasohol Study Group and the recommendations provided to the Department of ERAB, let me take a few moments to describe the way the Department seeks advice on scientific and technical matters. When the Department of Energy was established in October, 1977, it acquired a number of advisory committees from its component agencies. None of those advisory committees was constituted broadly enough to meet the needs of the Department for a wide range of advice on research and development.

As a result, the Secretary of Energy esstablished ERAB to provide advice and long-range guidance on a broad spectrum of energy-related research and development issues. The Board operates in compliance with the Federal Advisory Committee Act. Subcommittees are selected on the basis of a number of criteria, including their preeminence in the fields of technology which are the focus of Department R&D, their professional experience and insight into the relationship between scientific disciplines and energy issues and their working experience with the points of view of the industry, university, government and professional

communities. In its review of some topics, ERAB appoints study groups to develop additional facts for the Board's consideration. Use of these ad hoc fact-finding study groups, which are chaired by a member of the Board, provides an important opportunity to gain the knowledge of a number of experts who would not otherwise be involved in the advisory process. Use of these groups also allows the Board to respond rapidly to high-priority technical issues. Members of the fact-finding groups are selected by the Chairman of ERAB and the study group chairman, with the objective of obtaining technical expertise on the technical issue at hand. It is not intended that these study groups be advisory to the Department. Rather, their findings are presented to ERAB which, with its broader range of expertise and experience, is responsible for developing recommendations for the Department. This was the process used in developing the Board's recommendations on gasohol.

The need for the gasohol review first came up at a public ERAB meeting last fall. In response to a request from then Under Secretary John Deutch, the Board agreed to undertake the gasohol review and several other task assignments. Later that month, the Chairman of ERAB requested Dr. David Pimentel, of Cornell University and a member of ERAB, to lead an ad hoc fact-finding group on gasohol. Dr. Pimentel was selected because he is the resident ERAB expert in agricultural sciences. The study group was established to evaluate available technical and scientific data. As such, ERAB considered the membership balanced with the scientific and engineering disciplines needed to do the job.

The members of the study group were selected by the Chairman of ERAB. It is my belief that the group leaned toward a positive rather than a negative view of alcohol fuels in general. Dr. William Scheller of the University of Nebraska represented a strong advocacy point of view of the alcohol fuels industry. Dr. Paul Weisz of the Mobil Research and Development Corporation represented a balancing view that I would characterize as more pessimistic, but not anti-gasohol. Dr. Pimentel has co-authored papers on gasohol that took favorable positions toward advances in biomass energy systems and technology. Four years ago, while I was at Georgia Tech, I organized a group of engineers and scientists to help Brazil begin their ethanol development program. I also organized a continuing Alcohol Fuels group at Georgia Tech, and as Vice President for Research I was a very active member and supporter of alcohol fuels. Prior to becoming Assistant Secretary for Conservation and Solar Energy at DOE, I was a member of ERAB where, along with Dr. Pimentel, we stimulated interest in this area. The other members of ERAB had no prior opinions or involvement directly in gasohol production, but did have expertise in related disciplines. Overall, the Chairman attempted to select members with a satisfactory balance of viewpoints from geographic, industrial, academic and agricultural perspectives.

An informal session of the study group first convened in Washington on December 10 and 11, 1979. Minutes of the December 10 session and a transcript of the December 11 session were taken and made available to the public prior to ERAB's review of the gasohol issue at its February 7–8, 1980 meeting. A transcript of this latter meeting was also made available to the public. Public comments and ERAB comments were incorporated into the final report which was transmitted to the ERAB Chairman on April 29, 1980.

I would like to submit for the record a copy of a letter the Secretary recently forwarded to Congresswoman Virginia Smith. He states:

"As Secretary of Energy, I depend on many sources of advice to help me formulate the Department's programs and policy. Advisors, however, do not author the Department's policy. They contribute to the total body of information which must be considered in the formulation of policy. In the course of the process, I believe it is useful to examine diverse views because it ensures that all sides of an issue are aired and examined. The ERAB report is being considered in just this way. The report, however, has not caused me to alter my views concerning the potential of ethanol for use as fuel. The Department is actively engaged in the promotion of ethanol production and the utilization of gasohol. These efforts have my full support."

Let me now turn to the substance of the gasohol review. The study group's report is a broad overview of the multifaceted gasohol issue. It reviews pros and cons of the production of ethanol from grain or cellulose and methanol from coal. The issue of small-scale on-farm production also is addressed, but not in detail due to the lack of availability of technical data at the time of the study. This issue currently is being investigated by ERAB's Biomass Panel.

The Board's recommendations on gasohol should be considered in the context of the major goal of U.S. energy policy—that of reducing foreign oil imports. The Study Group which prepared the report determined the following with respect to ethanol production from grain:

A large state and U.S. Government program of economic supports for this method of alcohol production currently exists, and production is expanding rapidly based on these economic supports.

The production technology is mature.

Much of the ethanol is produced in oil- or gas-fired facilities and it is questionable whether any net new high grade fuel is produced utilizing this technology.

If the facilities for production of ethanol from grain were coal-fired, significant new net high grade fuel would be produced and imports would be reduced.

In summary, the report not only supports existing programs for encouraging ethanol production from grain, but also strongly recommends increased research in other areas of alcohol fuel production. I believe that it is a positive statement in behalf of alcohol fuel development and should be considered as such. I can assure you that it will not adversely affect our commitment to the development of alcohol fuels; rather, it will be carefully considered with other analyses and studies as alcohol fuel policy is developed.

With the review of the ERAB and the Gasohol Study Group as background I would like to turn to some of the key developments in alcohol fuels. As you know, in February, 1980, shortly after the President announced his alcohol fuels program initiative, several diverse alcohol fuels activities were consolidated within the Department and an Office of Alcohol Fuels was created, dedicated to achieving the President's goals. The Office went into operation within seven days of its establishment. It has already accomplished a great deal.

The Office has assessed and redirected previously-funded activities ranging from long-term research to short-term commercialization. A much needed alcohol fuels information collection, analysis and dissemination activity has been established. Management and control procedures have been put in place for quick implementation of the financial assistance program provisions of the Energy Security Act (S. 932).

In this regard, we have been working closely with the Department of Agriculture to coordinate the development of procedures and services that will be needed to implement this important legislation. $3.8 million has already been provided to the Department of Agriculture for feedstock research and for the placement of small stills on farms. We are also working with other departments and agencies including Department of Commerce, Department of Education, Department of Housing and Urban Development, Environmental Protection Agency, and the Small Business Administration to develop alcohol programs.

We have funded the initial cost of a technical assistance service at the Idaho National Engineering Laboratory. This service will not only assist in facilitating Department of Energy programs but will be available to the Department of Agriculture and other agencies that require technical expertise in their alcohol fuels programs.

We are also in the process of establishing an alcohol fuels laboratory at the Solar Energy Research Institute (SERI). This laboratory is expected to be a leader in alcohol fuels process research and demonstration.

We have recognized the importance of responsiveness to the Congress, the public, and industry. The Office of Alcohol Fuels has effectively handled 400 phone inquiries a day since its establishment. Overall, inquiries to the Department, its various information centers, and the Department's Office of Consumer Affairs have been received in unprecedented volume, numbering in the hundreds of thousands.

The Department's Office of Hearings and Appeals has expedited hearings on allocations for alcohol fuel producers and blenders. We have just proposed new regulations which are expected to speed up the allocations process even further. Public hearings on these regulations are scheduled to begin in two weeks.

We believe that rapid commercialization is essential to the success of this program. In that vein, an effort is now under way within the Department to award several new grants and contracts across the country before the end of this fiscal year.

Nearly 1,000 proposals for feasibility studies have been received by DOE in response to its alternative fuels solicitation under Public Law 96-126. Significantly, over 60 percent of these were for the production of ethanol. These proposals, from 47 states, represent a substantial financial investment on behalf of

the proposers as well as a commitment to produce ethanol. These plants would have a minimum capacity of one million gallons per year and would come on-line between 1981 and 1984. Our review of these proposals is on schedule and we anticipate starting the award process by the end of this month.

We have already started on our plan for implementation of the Energy Security Act in anticipation of the need to move quickly upon enactment. We have drafted loan guarantee regulations; all necessary forms, applications, and agreements are being designed; initial meetings have been held with USDA and financial institutions; experienced technical staff is now in place for proposal evaluation and review; and finally, one day conferences are planned at six major financial centers around the country to brief the financial community on the program's investment advantages.

Up to this point, I have discussed what the Department currently has underway in the alcohol fuels area. However, we have a number of programs still under development which deserve mention. Cellulosic conversion is the first of three which I would like to review today.

Presently, the greatest cost of ethanol production is for feedstock. If we can make alcohol from feedstock other than grain and sugar, we can reduce the cost of feedstocks significantly. We have recently directed SERI to bring together the foremost authorities in cellulosic conversion to determine the processes which appear to present the greatest opportunity for success. Based on their findings, we would consider initiating a research program with a goal of accelerating the introduction of commercial-scale production of alcohol from cellulose.

We are also studying the constraints and barriers to alcohol fuel production and marketing—from time consuming and costly Federal and State regulations to inequitable transportation tariffs—and developing working solutions to these problems.

Consumer protection is also important. We are now designing a "consumer information" program to provide the public with lists of manufacturers and producers of alcohol fuel products. It will serve a number of audiences from industry preparing to invest in production, to consumers buying the product at the pump. In addition, the planned alcohol fuels laboratory at the Solar Energy Research Institute will react to complaints and hearsay with controlled scientific analysis.

The Alcohol Fuels program has a positive future. Significant technical developments are needed, but we believe that these are within reach. Response to our solicitations indicates that the program has captured the ingenuity and resourcefulness of the country. Demand at the pump indicates that the American public is ready for alcohol fuels.

The Department of Energy is committed to the success of the program and achievement of the President's targets. We have every expectation of achieving those targets.

Senator McGovern. Thank you, Mr. Secretary, and we appreciate your appearance here today.

We will turn now to Mr. E. Stevens Potts, the former Acting Director of the Alcohol Fuels Office.

STATEMENT OF E. STEVENS POTTS, FORMER ACTING DIRECTOR, OFFICE OF ALCOHOL FUELS, DEPARTMENT OF ENERGY

Mr. Potts. Thank you.

Senator McGovern and Congressman Bedell, as you know, I am a staff member in the Office of the Secretary of Energy and I am currently on leave to pursue a short course in management at the Harvard Business School. For 3 months, I served as Acting Director of the Office of Alcohol Fuels in the Department of Energy. I would like to thank you for the opportunity to speak here today on one of my favorite subjects: gasohol.

I am proud of the administration's action on alcohol fuels. In the past 10 months we have moved very far toward making alcohol fuels a significant part of our Nation's energy mix. I'm glad to have played

a very small part in that. This progress can be seen not only in the actions of the Federal Government, but also where it is most important—in the marketplace. Gasohol is increasingly available to motorists throughout the country. Fuel alcohol production facilities are multiplying rapidly. I believe the President's goals, considered to be optimistic, can be met and I believe they will be met. This success has been the result of the dedicated efforts of thousands of people across the country—farmers, scientists, engineers, gas station operators, and others—and of the unwavering support for alcohol provided by the President, Secretary Duncan, and the Congress. I know that the administration's support will continue and I am sure that Congress will continue to guide and to assist our efforts.

Through your leadership, Senator, and that of Congressman Bedell and through the leadership of Senators Bayh and Congressmen Scheuer and Glickman and Wright and their staffs, to name just a very few, and through the efforts of Secretary Duncan and the President, we have established a momentum and the policies that will lead to the development of a successful and widespread alcohol industry in the United States.

When viewed in this context, I believe that the ERAB report on gasohol is no longer an important issue. I questioned some of the conclusions of the report, as you know, and I questioned certain aspects of the process through which those conclusions were reached. As far as gasohol is concerned, however, those issues are past.

Secretary Duncan has made his position public. He receives advice from many sources, but it is the Secretary himself, and not his advisers, who makes the policy of the Department of Energy.

As the Secretary recently stated:

> The report * * * has not caused me to alter my views concerning the potential of ethanol for use as fuel. The Department is actively engaged in the promotion of ethanol production and the utilization of gasohol. These efforts have my full support.

The Department's experience with this study group may raise some more general questions about the advisory comittee process. I understand that those general issues are being considered. But, insofar as alcohol fuels are concerned, I believe we should move ahead, as I know the Department and the Congress will, to promote strongly the advantages to our Nation of alcohol fuels and to meet the ambitious goals for alcohol production that the President has set.

I personally view alcohol fuel through gasohol as a first step the Nation is taking toward an independent energy future. It is the only alternative liquid fuel which will be commercially available in this country for the next 6 years. It will open the door for the marketplace for all other aternative fuels.

Senator, this completes my prepared testimony. I will be pleased to answer any questions at your convenience.

Senator McGovern. Thank you very much, Mr. Potts.

I now would like to ask the earlier witnesses to come back and join Mr. Stelson and Mr. Potts, and also Mrs. Tina Hobson, the Director of the Office of Consumer Affairs at the Department of Energy, to join in this portion of the hearing.

Mr. Potts, I want, first of all, to public acknowledge the debt that I feel the Department of Energy and the Congress and the public owes

to you for very conscientiously pointing out some of these inadequacies in the gasohol study group report. I realize you say that that issue is somewhat behind us, but the fact remains that we've got another biomass panel now beginning another study and five of the members on that panel are the same ones that were on the gasohol panel. Three of them were on the advisory board.

In any event, I'm very appreciative of what you've done and I know a number of other Members of Congress are. I'd like to just run through the following scenario on this study group, the Gasohol Study Group, and see if you concur that this is what happened. And if you do, I'd appreciate any comment.

On October 30 of last year, Secretary Duncan set a goal of 500 million gallons of alcohol fuel by the end of 1980. On November 15, the then Under Secretary Mr. Deutch, met with the advisory board to establish the study group and select its members. At least he met with the advisory board staff. He was careful to appoint one person who was favorable to ethanol production, Mr. Scheller. He was equally careful to appoint one person who's against ethanol, Mr. Weisz of the Mobil Oil Co., and the others on that board were supposedly neutral or favorable.

Then, on December 10 and 11, the study group met, I believe for the first time, and 2 days later they submitted a draft copy of its report to Mr. Deutch. On December 28, Mr. Deutch met with Secretary Duncan to lay out the policy options for alcohol fuels. It's my understanding that you were present at that meeting.

On February 8, Mr. Deutch attended an ERAB meeting where he called the study group report, "an outstanding example of successful advice and something that has made a difference." Now that was the first time, as I understand it, that the full advisory board membership learned of the study group's existence, let alone knowing anything about what was coming in the report.

On May 1, the advisory board met and voted to accept the study group report and then they sent it on to Secretary Duncan.

What I'd like to know is whether the scenario I have just described there fits your recollection of this process as it transpired.

Mr. POTTS. Yes, sir. I think it fits my recollection very closely.

Senator MCGOVERN. I'd like to ask Mrs. Hobson, who is supposed to protect the consumer on these matters in the Department, whether any aspects of these events constituted either improper or illegal procedures.

TESTIMONY OF TINA C. HOBSON, DIRECTOR, OFFICE OF CONSUMER AFFAIRS, DEPARTMENT OF ENERGY

Mrs. HOBSON. Senator McGovern, I am Director of the Office of Consumer Affairs, which also includes oversight. I am charged by Congress to implement the Federal Advisory Committee Act. I am in the Office of the Secretary and do report to the Secretary also through the Executive Assistant.

I would like to state and add to the record a few incidents which you have not mentioned. One of the things I would like to clarify, though, is when Secretary Duncan came to the Department of Energy he asked what issues and problems related to advisory committees

there were and at that time we brought up the problem of the unchartered subgroups. We are the only cabinet agency that has unchartered subgroups and we brought to him about eight issues that we felt were worthy of further review and a new look.

We have explored those issues. We have circulated them. We have gotten input. They are now sitting in the general counsel's office and they will be going to the Secretary shortly, within the next couple weeks. This hearing will be helpful to us in terms of exploring some of the problems.

Although unchartered subgroups are legal in terms of the definition given by our general counsel, and I don't doubt it, I think they possibly bring up occasions for misuse. I'd like to point out that we are protecting the consumer and we did watch this very closely.

The first meeting, as you know, was held December 10 and 11. I learned about this meeting personally on December 10 when it was in progress. There was no notice in the Federal Register, and there were no transcripts. I took a court reporter personally to that meeting and got a transcript of the second day because we felt the issue of alcohol fuels was so significant and of such public concern that we did not want the Secretary to be accused of a secret meeting. I think that was an important step.

I also would like to say that on December 19 I met with Ed Frieman, Director of Energy Research; Bill Bartley, who is one of the staff people for ERAB; and Mr. Buchsbaum, the chairman of the Energy Research Advisory Board, at their request. We reached an agreement, I thought, on some procedures related to unchartered subgroups. For instance, Ruth Davis, who is another Assistant Secretary, has the National Petroleum Council. The National Petroleum Council also has unchartered subgroups; but they are always announced in the Federal Register, the meetings are open, and there are minutes available to the public.

We discussed this and came to a conclusion, and I warned Chairman Buchsbaum, I said, "Your gasohol report is very significant. Will you assure me that it will not be used until it goes through the full committee?"—which includes three consumer members, including Amory Lovins. I was given assurance by Mr. Buchsbaum that he would not; he would make sure that it cleared the full committee before any information was presented to the Secretary.

On December 19, I received a copy of a memo from John Deutch. He forwarded a draft of a memo dated December 17 to several DOE officials for comment. The draft memo to the Secretary contained recommendations on the DOE gasohol strategy which Dr. Deutch stated was based on most importantly, the results of a committee of the Energy Research Advisory Board. That's exactly what Mr. Buchsbaum said he would not do.

I called Mr. Buchsbaum. I also wrote a memo to Mr. Deutch and objected. I said this is not an acceptable procedure under the Federal Advisory Committee Act for which I have responsibility.

Senator McGovern. Mrs. Hobson, just to clarify matters, we have a procedure here in the Congress where we use subcommittees but a subcommittee can't report a bill to the floor for action by either the House or the Senate. The subcommittee's work has to be first evaluated

and approved by a majority of the full standing committee before there can be any action.

Mrs. HOBSON. Right.

Senator MCGOVERN. Now, as I understand it, what you're saying is that the executive branch functions under the same general guidelines. Where you have a committee study, you can't bypass the full committee with a subcommittee report until it's been evaluated and approved by the full committee?

Mrs. HOBSON. That's correct. That's the usual procedure and I believe that's what is expected.

Senator MCGOVERN. You're saying that procedure was not followed?

Mrs. HOBSON. In this case, as far as my personal experience, Mr. Deutch stated that some of the information came from that report in a memo written for the Secretary. I personally objected to Mr. Buchsbaum and he, I felt, did not know that that step had occurred and he said he would talk to Mr. Deutch about it.

But as the situation continued—and I only have a couple more things—I did draft a memo to Mr. Deutch on December 20 and did object.

At the February 7–8 meeting, the gasohol study was discussed. Members of the public requested copies of the report from my staff, which was the preliminary report, and of course all materials and draft materials are available under the Federal Advisory Committee Act. The staff of ERAB declined to give out that report which we made public because it belongs in the public domain.

I also would like to say that we had to go to bat to have Richard Carlson testify at that meeting because he was turned down in terms of speaking publicly.

At the May 1 and 2 meeting, I called Amory Lovins 2 days in advance to see if he was coming in. There are three consumer people represented on the committee: Tom Cochran, Grant Thompson, and Amory Lovins. Mr. Lovins stated to me that he was not invited to the meeting. Amory Lovins is one of the people on ERAB who is most knowledgeable about alcohol fuels. He stated he was not invited. He had gotten a letter on February 26 from the ERAB staff stating that he would be notified by telephone of the exact date of the meeting. He travels considerably. I never have any trouble reaching him. I call Friends of the Earth and find out where he is and reach him immediately within 1 day.

So I asked that an alternate represent Amory Lovins. According to Amory Lovins, and I checked with him yesterday to see if that was correct, if any mail had followed and if he had picked up any additional letters, and he said, no, he did not. He's submitting a minority report. He did not approve the full report, and he will be writing his own minority report to the Secretary.

I do want to state that there were several other incidences that occurred but I think this is the basic outline of what happened, and I do want you to know that these issues will be considered by the general counsel and will be part of the options paper for the Secretary and that the Secretary has been concerned.

We are looking at it, and we do not want any abuse of the Federal Advisory Committee Act.

[The following supporting documentation was attached to Mrs. Hobson's testimony:]

DEPARTMENT OF ENERGY,
Washington, D.C., July 17, 1980.

HON. GEORGE MCGOVERN,
U.S. Senate,
Washington, D.C.

DEAR SENATOR MCGOVERN: Thank you for your letter of June 26, 1980, concerning the hearing on alcohol fuels policy.

In accordance with your request for documents supporting my statements during the question and answer period of the hearing. I am enclosing the following:

Memorandum dated December 4, 1978, from Thomas C. Newkirk, Acting Assistant General Counsel, Office of Legal Counsel, Subject: Applicability of the Federal Advisory Committee Act to Subgroups of Advisory Committees.

Memorandum signed November 21, 1979, from the Acting Director, Office of Energy Research to the Deputy Secretary, Subject: Energy Research Advisory Board Study Group on Gasohol.

Memo for the record written by Georgia Hildreth dated December 11, 1979, Subject: Energy Research Advisory Board Study Group on Gasohol.

Note dated December 19, 1979, from John Deutch to Worth Bateman, Ed Frieman, et al. with first page of draft dated December 17, 1979, to the Secretary of Energy/Deputy Secretary of Energy, Subject: Recommendations for DOE Gasohol Strategy.

Memorandum from Tina Hobson dated December 20, 1979, to John Deutch, Subject: ERAB Study Groups.

Memorandum dated February 8, 1980, from Georgia Hildreth to Tina Hobson, Subject: ERAB.

Memorandum for the File dated May 1, 1980, Subject: Problems Associated with Failure to Notify Amory Lovins of May 1 ERAB Committee Meeting.

Please let me know if I can be of further assistance.

Sincerely,

TINA HOBSON,
Advisory Committee Management Officer.

Enclosure.

DEPARTMENT OF ENERGY,
Washington, D.C., December 4, 1978,

Memorandum for: Tina Hobson, Director, Office of Consumer Affairs.
From: Thomas C. Newkirk, Acting Assistant General Counsel, Office of Legal Counsel.
Subject: Applicability of the Federal Advisory Committee Act to Subgroups of Advisory Committees.

Your memorandum, dated September 11, 1978, to the General Counsel asking whether National Petroleum Council (NPC) Task Groups are "advisory committees" subject to the Federal Advisory Committee Act and, if they are, whether they require separate chartering because the members of these subgroups are not members of the NPC, has been referred to this Office for reply. For the reasons expressed below, we are of the opinion that subcommittees and subgroups of an advisory committee that are not established or utilized by DOE for advice or recommendations, but rather are established by and only provide advice to their parent body, are not themselves advisory committees.

The Federal Advisory Committee Act, 5 U.S.C. App. I (FACA), defines an "advisory committee" to mean:

> any committee, board, commission, council, conference, panel, task force, or other similar group, *or any subcommittee or other subgroup thereof* (hereafter in this paragraph referred to as "committee"), which is—
>
> (A) establishd by statute or reorganization plan, or
>
> (B) established or utilized by the President, or
>
> (C) *established or utilized by one or more agencies,*
>
> in the interest of obtaining advice or recommendations for the President or one or more agencies or officers of the Federal Government.

5 U.S.C. App. I § 3(2) (emphasis supplied). The plain language of the definition clearly indicates that the subcommittee or other subgroup must itself be "established or utilized by one or more agencies, in the interest of obtaining advice or

recommendations for . . . one or more agencies or officers of the Federal Government . . ." Where a subcommittee is "established" by its parent entity—a federal advisory committee—it would not be established by an "agency." *See* 5 U.S.C. App. I § 3(3) (definition of "agency"). *See also Lombardo* v. *Handler*, 397 F. Supp. 792 (DDC 1975).

Moreover, if a subcommittee only provides advice or recommendations to its parent body, and not to any federal agency or officer, it cannot be said to be "utilized by one or more agencies, in the interest of obtaining advice or recommendations for . . . one or more agencies or officers", and, therefore, should not be an "advisory committee" under FACA.[1]

Had it been the intent of Congress to include as an "advisory committee" every subcommittee or subgroup of an advisory committee, then the phrase "or any subcommittee or subgroup thereof" should not have been placed among the list of entities which must satisfy certain conditions before they are advisory committees. In short, the placement of the phrase suggests an intent not to make all subgroups of advisory committees themselves advisory committees fully subject to FACA.

As a general matter the logic of FACA suggests as well that subcommittees which only advise the parent committee should not be considered advisory committees. FACA generally evidences an intent to protect the integrity of and to subject to public scrutiny those committees which themselves advise the federal advice which is given to the advisory committee itself, other than subjecting it to public scrutiny. See 5 U.S.C. App. I § 10(b).[2] Any interested person may seek to advise the advisory committee, see 5 U.S.C. App. I § 10(a)(3), with little or no government. There is no evidence of an intent to protect the integrity of the regulation of that person's integrity, objectivity, or independence. The safeguard is the fact that (1) the advisory committee is itself balanced and (2) it is almost wholly subject in its meetings and deliberations to public scrutiny. See generally 5 U.S.C. App. I § 10. Similarly, there is no logical need for a duplication of these safeguards at the subcommittee level. All the advice the subcommittee gives the parent committee will be subject to public scrutiny, comment and criticism, id. The balanced membership of the parent committee assures as well against biased advice. It would be inconsistent to read FACA to duplicate safeguards when subgroups are involved, but not when staff, consultants, contractors, individuals, etc. are involved.

There is, moreover, no suggestion in the legislative history or judicial construction of FACA that the plain language should not be given effect, as they are totally silent as to the question of subgroups of advisory committees. Moreover, OMB Circular A–63 (Revised), the formal OMB (now GSA) directive concerning implementation of FACA, does not address the subgroup question.

Less formal expressions of agency construction of FACA on this issue are in our view inconclusive. While OMB and Justice indicated at one point an apparent inclination to treat all subgroups of advisory committees are advisory committees themselves, see Draft Memorandum, noticed in 38 Federal Register 2306 et seq., January 23, 1973, subsequently OMB expressed the view that subgroups of advisory committees were themselves advisory committees only if they advised an agency directly, *see* letter dated May 22, 1975, from Robert P. Bedell Assistant General Counsel, OMB, to Irving Jaffe, Acting Assistant Attorney Gen-

[1] It might be argued that because a federal officer or employee must be present at or chairman of the parent body's meetings, see 5 U.S.C. App. I § 10(e), the subcommittee must of necessity be providing advice to a Federal officer if it provides advice to its parent group. It would seem, however, that where the subcommittee was created in good faith in the interest of providing advice to its parent collegial body, it would not be established in the interest of providing advice to a federal official merely because he was present at the meeting where such advice was announced or discussed.

It might also be argued that where the parent committee utilizes the advice or information of its subcommittee in formulating its advice to the federal agency, then it can be said that the subcommittee was utilized at least indirectly by the agency in obtaining advice. So long as the parent committee exercises its independent judgment, however, and does not "rubber-stamp" the subcommittee's action, this argument should fail or else every collegial entity which provided advice to the advisory committee would likewise become an advisory committee, and similarly every collegial entity which provided advice to the first collegial entity, ad infinitum.

[2] For example, the provision in FACA for staff and consultants to advisory committees, 5 U.S.C. App. I § 7(d), indicates no concern with respect to what support or input the committee receives. The use of subcommittees as the functional equivalents of staff or consultants logically should not be subject to any greater restrictions or constraints.

eral, Deparment of Justice.[3] Justice apparently concurred in this view in defeding *Metcalf* v. *NPC*.[4] Moreover, the fact that agencies may treat subgroups of advisory committees in much the same manner as they treat their advisory committees does not necessarily demonstrate that such treatment is legally required. That is, for policy reasons agencies may deem it desirable to place certain constraints on the subgroups of their advisory committees, a determination with which we would concur, see infra.

CONCLUSION

Based upon the foregoing, both the language and logic of FACA would seem to support the conclusion that subgroups of advisory committees are advisory committees only when they advise a federal agency for official, rather than their present group.

DOE is, nevertheless, responsible for all advisory committees which it establishes. It is, therefore, incumbent upon the Department to ensure that these committees' operations are properly carried out. DOE, if it is to adequately exercise this responsibility, must oversee the operations of the subgroups of these advisory committees, whether or not the subgroups are themselves advisory committees under FACA. While certain subgroups may not be "advisory committees" technically speaking, there may be factual situations which would justify the Department requiring such subgroups to comply fully with FACA procedures as a policy matter. By the same token, there may also be circumstances where compliance with all FACA procedures might be unnecessary and inappropriate. For example, it may not be necessary to require a broad balance, including non-industry representation, for a small task group which meets only to develop certain industry data which it will provide to the advisory committee, since the FACA protections will be effective when the advisory committee meets to discuss the data. As the Advisory Committee Management Office is responsible for advisory committee management within DOE, it is, in our view, that Office's responsibility to determine the proper policy for all subgroups of DOE's established advisory committees. In exceeding this responsibility, the Advisory Committee Management Office necessarily will be in a position to, and necessarily must, make or recommend decisions regarding which FACA provisions should be applied, as a policy matter, to those subgroups in any given instance.

DEPARTMENT OF ENERGY,
Washington, D.C., November 21, 1979.

INFORMATION MEMORANDUM

To: Deputy Secretary.
Thru: Under Secretary.
From: Acting Director, Office of Energy Research.
Subject: Energy Research Advisory Board Study Group on Gasohol.

PURPOSE

To provide the Deputy Secretary with information regarding the status of the Energy Research Advisory Board review of gasohol.

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[3] In an attachment to the letter, OMB discussed in some detail its consideration of the issue of the status of advisory committee subgroups by stating: "If the subcommittee is chartered then it is 'established'. The same criteria which would govern whether an advisory committee is being 'utilized' would govern whether a subcommittee of an advisory committee is being 'utilized'. The determination whether a group is being 'utilized' is factual in nature. . . . Although the factors are similar for determining 'utilization' for full committees as well as subcommittees, the additional question—again factual—with the latter is whether it is advising the Federal official as an advisory committee would, or whether it is advising the full committee."

[4] In this litigation, *Metcalf* v. *NPC*, 553 F. 2d 176 (D.C. Cir. 1976), the Department of Justice appears initially to have been of the view that all subgroups of advisory committees were themselves advisory committees. This view was opposed by Interior, OMB, and NPC, represented by private counsel in the suit. While the case was decided against plaintiffs on the basis that they had no standing, the Department of Justice proceeded in the suit with the position that not all subgroups of NPC were advisory committees, apparently adopting the OMB approach.

BACKGROUND

In response to John Deutch's commitment to the Deputy Secretary to review the gasohol issue, Dr. Solomon J. Buchsbaum, Chairman of the ERAB, is convening a special Study Group of the Board. This Study Group will be chaired by Dr. David Pimentel, a member of the Board from Cornell University.

DISCUSSION

The Study Group will meet here in Washington on December 10–11 (see attached tentative list of members). Dr. Pimentel understands the necessity for rapid response on this matter and plans to deliver a final report the week of December 24.

Attachment.

TENTATIVE MEMBERSHIP—ENERGY RESEARCH ADVISORY BOARD STUDY GROUP ON GASOHOL

Dr. David Pimentel, Chairman,[1] Cornell University.
Dr. Charles Coonie, Mass. Institute to Technology.
Richard L. Hinman,[1] Pfizer, Inc.
William Scheller, University of Nebraska.
Thomas Stelson,[1] Georgia Institute of Technology.
Paul Weiz, Mobil Oil or John McCullah,[1] Mobil Oil.

DOE STAFF SUPPORT

Sandy Harris, Conservation and Solar.
Robert Rabson, Energy Research.

DEPARTMENT OF ENERGY,
Washington, D.C., December 11, 1979.

MEMO FOR THE RECORD

Subject: Energy Research Advisory Board Study Group on Gasohol.

I first learned of the ERAB Study Group meeting on Gasohol at approximately 9 a.m. on the 10th when Fern handed me the attached undated memo from the Acting Director, Office of Energy Research, to the Deputy Secretary. Evidently Bill Holmberg had obtained a copy and had sent it to Karl who in turn brought it to Fern's attention.

The meeting was already in progress. I called Eudora Taylor in Bill Bartley's office to ask why the meeting had not been advertised in the Federal Register and opened to the public. She said something to the effect that she was under the impression from General Counsel that study groups would not fall under FACA but that she had been out of the office last week and really did not know the story.

Bill Bartley called me—I told him the meeting should have been advertised and open because of so much interest in gasohol—also, that another committee, the Gasoline Marketing Advisory Committee, has been concerned with the subject from their viewpoint and have it on the agenda for their March 1980 meeting. I asked Bill how the full Board could possibly review the report and he said it would be sent to them. When I insisted there was no way the full Board could review the report and deliver a final report by December 24, he said that it would be reviewed by the ERAB Chairman. He said there was not time to put a notice in the Federal Register—that Steve Potts had directed the study.

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[1] ERAB members.

At that point, believing that interested members of OCA staff were already aware of the meeting, I put a call in to Paul Lewis, GC, to let him know an illegal meeting was in progress—Paul did not call back. I called Ivan Maple, ERA, & told him of the meeting & suggested they might want to have someone attend.

A copy of the attached statement which was read into the record at the GMAC meeting was delivered to Bill Bartley.

GEORGIA HILDRETH.

DEPARTMENT OF ENERGY,
Washington, D.C., December 19, 1979.

NOTE FOR: WORTH BATEMAN, ED FRIEMAN, BENNETT MILLER, ED BLUM, LES LEVINE, AND STEVE POTTS

Enclosed is a rough draft of an alcohol fuels memo I intend to send to Charles. I would be most interested in your comments and ask your particular attention to checking the accuracy of the numbers cited.

Please let me have your comments by Christmas Day.

JOHN DEUTCH,
Under Secretary.

Enclosure.

DRAFT—DECEMBER 17, 1979

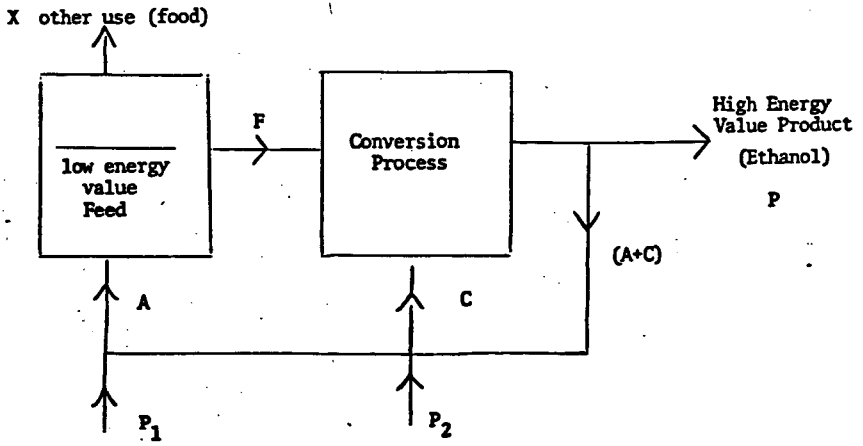
Memorandum for: Secretary of Energy, Deputy Secretary of Energy.
From: Under Secretary.
Subject: Recommendations for DOE Gasohol Strategy.

As promised I am providing my recommendations to you concerning the strategy and associated initiatives DOE should adopt in pursuing gasohol. In arriving at these recommendations, I have relied upon (1) the views expressed by the CS program office, (2) various analyses prepared by PE, (3) several studies recently published by private experts and, most importantly, (4) the results of a Committee of the Energy Research Advisory Board (ERAB) that I asked to perform a brief review of some outstanding issues concerning greatly expanded usage of gasohol.

My recommendations have also been formulated in the broader context of existing and planned Federal programs/incentives and of Congressional attitudes. For example, it should be remembered that there is in place a formidable incentive for near-term ethanol production in the exemption to the 4¢ gallon Federal excise tax for gasohol (equivalent to a $16/b ethanol production tax credit) which is augmented by state gasoline tax exemptions in many places. The Federal tax exemption is likely to be and should be extended beyond its current expiration date of 1984. In addition, both DOE and DOA have substantial R&D and demonstration programs in place; the DOE program directed toward advanced technology development, *e.g.*, continuous fermentation, cellulosic conversion and the DOA program directed toward on-form systems. Finally, Title I (Talmadge) and Title III (Church) of S. 932 including sweeping new and potentially expensive (up to $6b) initiatives for gasohol/biomass that would augment the $1.0b reserved under Title I for funds from biomass in the Synthetic Fuels Corporation.

There is little question that gasohol has great public appeal and consequently strong Congressional support. The question is how DOE and the Administration can undertake a constructive leadership role without succumbing to endorsing popular, but costly, measures that are not justified on the basis of cost/effective contributions to our near or long term energy problems.

The principal issues concerning gasohol can best be examined by consideration of the following schematic of a "high value" fuel energy production system:



The figure indicates that the high energy value product (P) requires an amount of low energy value feed (F) reduced by an amount of high value fuel ($A+P_1$) required for production and by an amount of high value fuel ($C+P_2$) required for conversion. The high value energy processing streams for production ($A+P_1$) and conversion ($C+P_2$) are composed of recycled product streams (A and C respectively) augmented by external product streams, e.g., natural gas or diesel, designated by P_1 and P_2. The use of fuel production (F) must compete with other uses (X).

The characteristics of an energy efficient and economical synthetic fuel system are:

The value of the product P is large compared to other uses for the feed X.

The high value energy requirement for production ($A+P_1$) plus conversion ($C+P_2$) are small compared to the energy product stream P.

The following major points are made concerning gasohol production:

(1) Feed costs (grain or sugar) represents over 70 percent of the estimated product cost of ethanol (estimated to be $1.20/gal. at the plant gate). This suggests that conversion process improvements, e.g., continuous fermentation will have little impact on lowering ethanol price. On the other hand, the development of efficient processes for cellulosic substrate conversion would be most attractive.

(2) The projected world and domestic demand for grain and sugar for food use (X) is expected to grow substantially in coming decades. This trend is expected by most independent experts to cast doubt on the advisability of dedicating large amounts of cropland to ethanol production. A reasonable upper limit for incremental grain cropland dedicated to ethanol feedstock production has been estimated to be 3.5 gals/year (representing 1.5b bushels of grain grown on approximately 20 million acres or 5 percent of presently developed cropland).

Agricultural residues is another source of feedstock but this use has a hidden cost in terms of soil erosion and nutrient depletion that must be considered.

The net result is that ethanol production from cereal grains or sugar in the U.S. should only be seen as a short term measure during the next 10 or 15 years. In the rest of the world ethanol production from agriculture depends greatly on local circumstances, e.g., sugar cane production in tropical countries, and improved agricultural productivity.

(3) A major issue that is debated with regard to ethanol production concerns the need for large amounts of high value fuel input for agricultural production (P_1) and conversion (P_2). On an energy basis a gallon of ethanol plus by-product credits, has an energy value of approximate: 90,000 BTU. To produce this gallon, 45,000 BTU is required for farming (P_1) and 69,000 BTU for fermentation conversion and distillation (P_2, natural gas or diesel) leading to a net high value fuel loss of approximately 15,000–20,000 BTU/gal. In the future

if coal can be substituted for the conversion energy requirement, P_2, the net high value energy production per gallon of ethanol would be almost 53,000 BTU/gal or approximately (⅔) the thermodynamic energy value of the ethanol. The point is that ethanol production, in contrast to synthetic liquids from coal, requires appreciable quantities of high value fuel per unit product.

It has been argued by some, based on uncertain data that the effective net energy value of ethanol should be judged on a volume basis rather than an energy basis. The reason given is that when ethanol is mixed with gasoline, more complete combustion of the gasoline is realized, thus enhancing the practical energy value of the gasoline. This enhanced combustion can be attributed to the ethanol fraction which results in an effective energy content of ethanol approximately equal to gasoline. If ethanol in gasoline has an effective energy value compared to gasoline on a volume basis, the net eneregy content of ethanol shifts to +35,000 BTU/gal with high value fuel for conversion P_1, and +105,000 BTU/gal if coal is substituted for P_1. However, the data on the volume equivalency of ethanol is highly uncertain and clearly depends upon engine characteristics. In order to improve our understanding of this important question of volume or energy basis, the Office of Energy Research will be undertaking immediately additional experiments.

(4) Methanol from coal is, in the long run, the most important competitor to ethanol from agricultural feed stock. Note that in the production of synthetic liquids from coal high value energy requirements for production ($A+P_1$) are small and the high value energy requirements for conversion ($C+P_2$) are minimal (most of the energy required for conversion is supplied by the coal feed F). Estimates of the cost of methanol production from coal lie in the range of 60¢–80¢/gallon compared to ethanol cost of approximately $1.20/gal. But methanol has an energy content approximately 20% less than ethanol (Methanol 65,000 BTU/gal, ethanol 85,000 BTU/gal, gasoline 110,000 BTU/gal. so that on an energy basis methanol costs 85¢ compared to an ethanol cost of 110¢.

It should be noted that ethanol is a more desirable gasoline additive than methanol because of the latter's polarity that leads to greater corrosion, poorer mixing with gasoline, and greater affinity for water. Accordingly, it is pertinent to undertake R&D on methanol catalytic, conversion to other compounds e.g., ethers or gasoline directly. DOE is sponsoring such R&D, in particular with Mobil on their M-gasoline molecular sieve process.

(5) The great advantage of ethanol production particularly in the short run compared to methanol or other synthetic fuels is that economical plant sizes are much smaller, e.g., 50 MM gal/year/3,300 b/d) ethanol versus 50,000 b/d capacity for methanol from coal production. The capital cost requirements for ethanol plants (approximately $20,000/b capacity) are lower than synfuels coal plants (approximately $40,000/b capacity) reflecting the high variable feed costs of grains in contrast to coal in the respective conversion processes. In addition, there is considerable opportunity to expand existing ethanol capacity and place on-line presently idle distillery capacity although much of the idle capacity is inefficient and probably configured for diesel or natural gas energy use (P_1+P_2). Finally, there is maybe a need for specialized "topping plants" that will dehydrate 160 proof ethanol produced in small quantity by communities and cooperatives to any hydrous grade. The following table summarizes ethanol plant requirements and present understanding of Federal agency responsibility.

Plant type	*Federal responsibility*
Small on-farm or cooperative plant (less than 500,000 gal/year).	Agriculture.
New large-scale plants (50 MM gal/year).	Energy Security Corporation with purchase/price guarantees loan/guarantees.
Middle-size plants (1 MM to 5 MM gal/year) if appropriate, existing distillery conversions, specialized topping plants.	DOE perhaps with loan guarantees and cooperative agreement funds obtained under S. 932.

GOALS FOR GASOHOL

Ambitious goals have been proposed for gasohol compared to present ethanol production of 100 MM gal/year from agricultural feedstocks increasing to 500 MM/gal/year by the end of 1980 and 3600 MM gal/year by mid-1980. In my judgment such a goal is unrealistic in terms of (1) the pace at which new production capacity can be put on-line, (2) the actual benefits, particularly in the short run, in terms of net oil saved, (3) the economic costs whether it ap-

pears in the Federal budget, as tax expenditures, or is borne by the private sector, (4) the impact such use might have, in the future, on food production, and (5) premature commitment to ethanol from grain or sugar production in contrast to technology development leading to use of more abundant and cheaper cellulosic feedstock. I abhor setting fashionable goals that are likely not to be met and that are not justified by objective analysis of the likely costs and benefits to our overall energy future.

An alternative goal that I do support as more realistic in light of factors listed above is 20 percent of present U.S. unleaded gasoline blended with 10 percent ethanol from agriculture by the mid-eighties. Such a goal is ambitious but I believe both achievable and more consistent with the facts. The increased ethanol production (a factor of approximately 8 over today's capacity) should be accompanied by aggressive process improvements leading to more energy efficient ethanol production, i.e., reducing P_2 by converting to coal.

The following table summarizes the proposed goal:

	Gallons per year
1. Present unleaded gasoline consumption	40 billion.
2. 20 percent Gasohol	8 billion.
3. 10 percent Ethanol requirement	800 million. (55,000 barrels per day).

This incremental 700 million gal/year capacity should be provided by a mix of expanded capacity, new plants of large scale, on-farm systems and presently idle capacity. The capital requirements would be in excess of $1b, much of which could be provided by the ESC and other measures presently under consideration in S. 932.

RECOMMENDATIONS

Much remains to be done to strengthen our Government-wide activities on gasohol in order to meet the goal I have recommended. In this section I will summarize the additional initiatives that I would recommend you to undertake in this important area:

1. Set a 20 percent goal by the mid-1980's.
2. Immediately establish an Office of Alcohol Fuels in CS, including the alcohol fuels that are currently in the Biomass Branch.
3. Continue to press for use of the fiscal year 1980 $2.2B synthetic fuels appropriations for the development feasibility studies and cooperative agreements for ethanol production. This should include, in particular, attention to new large alcohol plants, specialized topping plants and perhaps some middle-size plants.
4. Support in the context of S. 932 authorization for DOE to issue loan guarantees and perhaps for medium scale alcohol production facilities, conversion and processing improvements in existing facilities, and specialized topping plants.
5. Direct a carefully designed experimental program for wide-spread gasohol use in the DOE vehicle fleet on a phased-in approach.
6. Designate a single secretarial officer to be in charge of reviewing the gasohol efforts. I would suggest Tom Stelson who is an expert in this area.
7. Prepare a fiscal year 1980 supplemental request for additional alcohol fuel activities.

	Millions of dollars
A. Increased effort in improving energy efficiency and reducing capital requirements in conversion, fermentation and distillation for alcohol plants	$10
B. Increasing innovative alcohol production with particular emphasis on conversion of cellulosic wastes to alcohol (a portion of these funds may be allocated to the new process at the University of Arkansas)	10
C. Public information, studies, and evaluation activities sponsored by the Office of Alcohol Fuels	3

The total supplemental would be $23 million, which I believe could be successfully advocated with OMB at this level.

DEPARTMENT OF ENERGY,
Washington, D.C., December 20, 1979.

Memorandum for: John Deutch, Under Secretary.
Subject: ERAB Study Groups.

On December 19, Ed Frieman, Solomon Buchsbaum, Bill Bartley, and I met to discuss how my office could be more responsive to ERAB. We concurred on the need for better meeting rooms and for making coffee available. In addition, I believe we even concurred on supporting a position of flexibility for subgroup meetings to include:

Notice in the Federal Register;
Transcripts of the meetings;
At least two members of the parent ERAB on each subgroup;
Submission of reports in preliminary draft form to parent Board for approval before they are submitted to the Secretary;
Notification of all members of ERAB of subgroup meetings.

I think these steps are necessary to comply with the intent of the Federal Advisory Committee Act but at the same time will allow the Department leeway to obtain needed expertise and advice from a broad base of experts. In addition, these procedures will lend credibility to reports received and will avoid the appearance of establishing groups to "rubber stamp" DOE policy.

The attached memorandum dated December 19, 1979, is unfortunate. It implies that the results of the alcohol subgroup were available by December 17, 1979. To be accurate shouldn't you say in the first paragraph: ". . . The preliminary findings of an Energy Research Advisory Board Study Group on Gasohol (not yet reviewed or supported by the full Board) . . ."

Also, you might want to say, "The Study Group consisted of: Dr. David Pimentel, Chairman,[1] Cornell University; Dr. Charles Coonie, Massachusetts Institute of Technology; Richard L. Hinman,[1] Pfizer, Inc.; William Scheller, University of Nebraska; Thomas Stelson,[1] Georgia Institute of Technology; and Paul Weiz, Mobil Oil or John McCullah, Mobil Oil.

It is of particular importance that the full Board review the report on gasohol since otherwise the proposed new members, including Amory Lovins and Grant Thompson, will have no input into it.

TINA HOBSON,
Advisory Committee Management Officer.

FEBRUARY 8, 1980.

MEMORANDUM FOR TINA

From: Georgia.
Subject: ERAB.

Section 8(a) of the FACA states that the ACMO shall exercise control over the establishment procedures and accomplishments of advisory committees . . . and assemble and maintain the reports, records and other papers of any such committee during its existence.

We have the following problems which occurred at the 2/7–8/80 ERAB meeting:

1. Refusal to give a member of ACMO staff a copy of the draft Gasohol Study Report which was on the agenda for discussion.
2. Apparent reluctance to grant Richard Carlson's request for a few minutes on the agenda to make a presentation on gasohol.

Item 1—On the 7th we had requests from members of the public for the Gasohol Report. As there was not a copy available in my office we told individuals making the requests that we would obtain it.

On the 8th Gloria went to the meeting and asked David Pimentel (Study Group Chairman) for a copy of the report. Pimentel told her that he had the latest "marked-up" version but had been instructed by Bartley not to give it out. He told Gloria that he would hand it to Eudora Taylor and that Gloria could obtain it from her. When Gloria asked Bill Bartley and Eudora Taylor for the Report, Bill asked which one she wanted—said there were about 8

[1] ERAB members.

versions—and she said she wanted the latest one. He and Eudora refused to give her the report and did not pass any copies to the public. (The previous day material was distributed to the public on other subjects). Subsequently I discussed the matter with you and discovered that you had a copy of the report which we then copied and passed out to the public.

Item 2—Late on Feb. 6 we were asked by Richard Carlson, Research Associate/Economist, Center for the Biology of Natural Systems, Washington University at Saint Louis to see whether he could address the Board on the gasohol issue. Gloria asked Bill Bartley and Eudora if he could be put on the agenda. When we had no answer by the evening of 2/7, Mr. Carlson decided he would come to D.C. and hope that he would have opportunity to address the Board. When Mr. Carlson arrived Gloria informed ERAB staff. At noon on the 8th the decision seemed to be that he could not make an oral presentation—although his written critique would be accepted. Later, after lunch, he was allowed to orally present his views.

In accordance with Section 10(b) of FACA any documents made available to advisory committee members shall be available to the public. Members of the public attending the meetings naturally want the documents while they are being discussed and it is certainly good public relations to make them available at that time since we are going to eventually have to make them available.

The FACA also states that interested persons shall be permitted to attend, appear before, or file statements with any advisory committee subject to such reasonable rules or regulations as the Director of OMB may prescribe. OMB Circular A–63 states that "Interested persons may be permitted by the committee chairman to speak at the meeting in accordance with procedures established by the committee.

DOE policy as set forth in the proposed Manual (and not refuted by any of the program office) in practice since DOE's inception is to allow at least 15 minutes on the agenda for public comment.

Incidentally, in closing the meeting on the 8th, the Chairman instructed the members that if they are every approached (even by Secretary Duncan) for a report they are still working on, they should refer all such requests to the Executive Director of the Board, Tom Kuehn.

How should we handle the situations outlined above?

DEPARTMENT OF ENERGY,
Washington, D.C., May 1, 1980.

MEMORANDUM FOR THE FILE

From: Tina C. Hobson, Director, Office of Consumer Affairs.
Subject: Problems Associated with Failure to Notify Amory Lovins of May 1 ERAB Committee Meeting.

On April 29 and 30, I spoke to Hunter Lovins and Amory Lovins with reference to the May 1 and 2 ERAB meeting. The following statements were made:

Neither Amory nor Hunter knew about the May 1 and 2 ERAB meeting. They said they had not received either a notice in the mail or a telephone call. They had left copies of their itinerary with DOE staffers but had not been reached. Their itinerary of travel was complex but they were reachable by phone.

February 28–March 4 Germany.
March 29–April 12 Japan.
April 12 to present in the U.S.

They said that the last written communication with ERAB was on February 26 and indicated that there would probably be an ERAB meeting in the early part of May but stay would be calling "in a few days to fix the date."

I talked with Jeff Knight in the Friends of the Earth office in California in the process of locating Amory and Jeff said he had not received any information on the ERAB meeting.

Tom Cochran, also a "consumer" member of ERAB called Dr. Kuehn and was told that Amory had been routinely notified of the meeting just like everyone else.

Amory then called me and stated that Dr. Kuehn had talked with him and said "since your itinerary indicated you couldn't come on May 1 and 2, I did not notify you." Dr. Kuehn also told Amory he could not have an alternate attend the meeting for him—the policy of the committee prevented alternates.

Since the February 8 transcript of the Energy Research Advisory Board meeting listed Richard Alban as an "Alternate" to Roland Schmitt, General Electric Company, I think the concerns of Friends of the Earth may well be that if it's alright for General Electric to send an alternate, why isn't it alright for Friends of the Earth?

Amory asked that we contact David Marsalli or Ken Bossong to represent him at the meeting. I could not locate David Marsalli until the morning of May 1. Ken Bossong was able to come for part time and did arrive in my office at 8:30 a.m., May 1. I talked with Ed Frieman the evening of April 30 and notified him that Amory had asked for an alternate since he had not received notification of the meeting.

When I introduced Ken Bossong to Sol Buchsbaum, Chairman of the Committee, and asked that he be permitted to stay as an alternate, Mr. Buchsbaum said that no alternates were permitted to attend the meeting. I mentioned that Amory Lovins had not been told of the meeting or at least had not received any correspondence fixing the dates. I also pointed out that in the official minutes of the February 8 transcript, Richard Alman was listed as an "Alternate." Mr. Buchsbaum said that was an error. Alban had joined the Committee (and was seated next to Tom Cochran at the Committee table) for a short time to comment on a special study in which he had participated. He suggested that Ken Bossong sit in the audience and speak during the public comment period.

Ken Bossong and I just talked with Amory Lovins and reported to him the fact that Ken was not permitted to be his alternate during the meeting. Amory repeated:

That the February 26 letter which he received in London said the meeting would be sometime in early May and that he would be called "in a few days to fix the date."

He was not called nor did he receive any further indication of the Committee meeting until Dr. Kuehn called him at the request of Tom Cochran on April 29.

Amory said he was easily reachable after March 20 and has been in this country since April 12. He was not notified of the meeting date although he was available.

Via this telephone call, Amory asked Ken Bossong to represent him during the public comment period and report:

That Amory Lovins was not notified of the meeting via a phone call or a letter.

He did not have an opportunity to comment on the final draft of the gasohol study.

If the final draft does not contain sizeable changes in the following three areas then it would be completely distorted as to content and should not be sent forward to the Secretary.

1. Scale of efficiency of production.
2. Nature of feedstocks and integration with agricultural reform.
3. Methanol production.

Amory would like the opportunity to review the final draft and comment before it goes to the Secretary.

Not having seen the final draft he would be forced to vote today against accepting it although he could not at this time comment as to substance.

If he is not permitted to comment prior to the Secretary receiving the report then (depending on the changes made to the existing draft) he would write a separate minority opinion to the Secretary and request assurance that the minority opinion be given the same distribution provided the ERAB report.

Senator McGovern. Thank you, Mrs. Hobson, for your observations.

Secretary Stelson, I have just a couple of questions I wanted to direct at you. When were you nominated for the post of Assistant Secretary, do you recall?

Mr. Stelson. I believe it was October 20.

Senator McGovern. When were you appointed to the gasohol study group?

Mr. Stelson. Well, I was at the meeting on December 10 and 11. It was earlier than that.

Senator McGovern. That was the first time, I guess the only time, the study group met. Is that correct?

Mr. STELSON. As soon as I was confirmed, I had no further involvement with the Energy Research Advisory Board. However, I did make a presentation to them at their request in the area of energy conservation, and I am familiar with that one meeting which I attended.

Senator MCGOVERN. On December 10 and 11?

Mr. STELSON. That's right.

Senator MCGOVERN. That was the gasohol study group?

Mr. STELSON. That's correct. I have been a member of ERAB since it was founded earlier.

Senator MCGOVERN. Yes. Now you were confirmed by the Senate, I'm told, on December 20.

Mr. STELSON. That is correct, and I was sworn in on January 7.

Senator MCGOVERN. I think you were confirmed on the 20th and then sworn in on the 7th.

Mr. STELSON. Yes.

Senator MCGOVERN. One thing that concerns me, during all of that period before you were sworn in on January 7 when you were serving as a member of the gasohol study group, is it not a fact that during that period you had to report directly to Mr. Deutch who was your immediate superior, and knowing his strong opposition to the whole gasohol development program, doesn't that make it difficult for you to bring an unbiased and scientific approach to this whole question?

I mean, it seems to me if you had been on the study group at the time when you had already been confirmed by the Senate——

Mr. STELSON. I hadn't been confirmed.

Senator MCGOVERN. I say, if you had been, you would have had a little more freedom and independence of operation. Here you are, in effect, in a state where your appointment is pending. That appointment itself is obviously dependent upon the approval of Mr. Deutch and he's your superior, and yet you're asked to come up with findings that conceivably could be quite at variance with his. Just from what I know about this issue, I'm certain that I wouldn't have agreed with the findings of that study group that more or less relegated farm-based alcohol fuels to a very minor part of this whole operation.

But what I'm trying to get at is, it seems to me there's at least some implication that members of that study group were not entirely unbiased and free in the judgments they made, and I'm wondering if you think that might have been true in your case.

Mr. STELSON. I'll be glad to comment on that. As you may or may not know, John Deutch and I have many differences of opinion. I work for him. I respect him. He's an outstanding scientist and administrator. We discussed alcohol fuels at length after I was sworn in because it was an area of my primary responsibility. The main discussion centered around the fact that the 4-cent-a-gallon tax rebate, under law, would expire at that time in 1984. I told him, and I think he agreed, that the potential for alcohol fuels production was very much greater than it appeared in the ERAB report, but it was absolutely critical that the tax condition extend more than 4 years. In fact, in the President's program he recommended an indefinite extension. It's my understanding that Senate bill 932 extended it until 1992.

Although a number of people here have said Mr. Deutch was anti-gasohol development, I personally never found that to be true. I found that he was quite openminded and most receptive to suggestions that would enhance and improve the development of alcohol fuels. So I had no conflict with him.

Senator McGovern. Well, I think the reason people feel that he has a bias against it, Mr. Stelson, is that he seems to favor these extremely low estimates of the potential. President Carter has established a national goal for alcohol fuel production of some 2 billion gallons by 1985, some 5 years hence. The ERAB report indicates this goal can't be reached. I think they set a figure of something less than half of that without creating food and fiber problems.

Who do you think is right, the gasohol study group or the President?

Mr. Stelson. Well, I think the report is substantially misinterpreted. I discussed with Mr. Deutch the mechanisms for substantially expanding alcohol fuel production and goals and in particular discussed with him the goal of the 500 million gallons per year production rate by the end of 1981. I recommend particularly that that be coupled with other activities that would make for a cohesive, constructive alcohol fuel development program.

He was quite receptive to that advice and supportive of it. As I said before, this was a research advisory committee and the main thrust was not the commercial development of fuel but what areas of research DOE should be pursuing. The committee pinpointed the food and fiber issue as one of the key areas of constructive research. I think, in general, everyone would agree with this finding.

So I do not consider that a negative recommendation but a very positive recommendation that's helpful to the development of alcohol fuels.

Senator McGovern. Let me turn now just briefly to some of the other members of the panel.

Mr. Commoner, your ultimate alcohol potential production number of 150 billion gallons seems very large, but as Mr. Campbell I believe stated, a new University of Pennsylvania report bears out that general figure.

As you know, the gasohol report emphasizes the long-term importance of cellulose and coal-based methanol and it relegates farm-based ethanol to a minor role. It's talked about as low as 200 to 900 million gallons a year.

What is your view as to the role farm-based ethanol can play in our liquid energy future?

Mr. Commoner. I think to begin with, it ought to be the cutting edge of the entire alcohol program. That is, it's already been made very clear that alcohol production from crops is the quickest way to put alternative liquid fuels into the energy budget, and I think that is the most immediate point.

The other point to make is that gasohol itself is an important substitute for unleaded gasoline and all the evidence I have seen indicates that that's the supply of gasoline which is going to be shortest over the next probably 10 years. In other words, we can anticipate gasoline lines that arise from the shortage specifically of unleaded gasoline. The last shortage was an unleaded gasoline shortage.

Therefore, the immediate production of gasohol would have the benefit of relieving the country of the danger of gas lines due to the inadequate refinery capacity for making unleaded gasoline.

Senator McGovern. What about this fear that you hear frequently expressed that the widespread use of farm-based products for gasohol is going to impact on the Nation's food supply? There are reports that we are all aware of I think of an impending shortage worldwide of food. How does gasohol production on the scale you're talking about impact on the world's food supply?

Mr. Commoner. The point I made in my original statement is that, properly organized, agriculture can product the gasohol with no reduction in food production. More than that, if you take a dynamic view of this, the puting in place of an alcohol production system from agriculture wil begin to give the country the equipment that it needs to expand alcohol production generally.

The point that has to be made is that the cellulose step will use the same fermentation technique that can already be used with starchy and sugary crops. In other words, what I'm saying is the way to get the program is to begin immediately with extensive production of alcohol from crops, including the introduction of sugar crops, so that there's no impact on food production. Then, when the cellulose process comes into place, that can simply be put in front of the existing alcohol fermentation system so that we can expect literally starting with alcohol production on the farm to go to full substitution of ethanol for gasoline. We would then have to add additional fermentation schemes to get butane diol which brings the figure up to 150 billion gallons.

The point I wold make is in any sensible plan you would start immediately with a heavy program of producing alcohol from crops, modifying the crop system, and preferably doing it on an on-farm or a cooperative scale.

Senator McGovern. Just one other question to you, Mr. Commoner, and then I want to give Congressman Bedell a chance to ask some questions.

I think it was Mr. Mavis who said that he disagreed with the observation in the Mobil ad that politics and scence don't mix. A good many of our scientific studies are funded by the Government, including some of the ones you mentioned that go to you own university.

It seems to me what's less likely to mix well in the public interest is to have people who have an economic self-interest in the outcome of a particular Government study having their people doing the study and telling the rest of us what's in our interest.

Now what I'm talking about is a rather blunt question I'd like to put to you—whether Mobil Oil stands to gain from the release of reports such as the one by the gasohol study group of the Energy Research Advisory Board because it is a fact that they had consultants and employees of that company in a sense sitting on the study group that made the recommendations? I'm wondering if you see a conflict of interest there and, if so, what is it?

Mr. Commoner. I think there is a serious conflict of interest in the behavior of Mobil Oil in connection with providing its staff and consultants to provide advice to DOE. The reason is quite simple. Mobil has heavy investments in a conflicting alternative to ethanol production; that is, the production of methanol from coal. This goes back to

the fact that they have holdings of coal which, for example, are heavy in agricultural counties such as Madison and Macoupin Counties in Illinois, which in fact are very extensive corn and soybean acreage.

I've recently been in Knox County, Ill., where it is clear that the strip mining of coal is going to seriously disrupt the long-term agricultural output of that area, and the fact is that Mobil has holdings in Illinois where there is a direct contradiction between the conversion of the mining of that coal and the use of that land for agricultural purposes. It seems to me that's where it begins.

The second point is—and it's already been mentioned—that Mobil stands to start the commercial development of methanol from coal because they hold the patents on what is probably the most useful way to use methanol in automotive transportation. As has been pointed out I think before in my prepared statement, methanol, unlike ethanol, has difficulties in being used in automotive engines. There are problems with material deterioration and so on. And you could foresee a scenario of this sort: that if a methanol program were heavily developed and large amounts of methanol were produced and it was discovered that it was difficult to mix it with gasoline successfully and in fact difficut to ne in ordinary engines, along would come Mobil to tell us, don't worry, we have a method for converting it into gasoline and then all will be well.

I think it's clear that beginning with coal and the conversion of coal to syn fuels generally and in particular the conversion of methanol into gasoline, Mobil stands to gain considerably from this direction. It has very heavy investments which I can list for you. Something thats' already been mentioned is the activity in West Germany. It's got a program going in Wyoming. It even has one going in Australia. Mobil is heavily involved economically in what I regard to be a process that is antagonistic to the development of ethanol. It's antagonistic right at the point of the soil. If you begin to mine the agricultural lands of Illinois, you will interfere with the use in food and fuel production.

And it seems to me—and I have said this before and I'll say it again—that what serves Mobil's interest is the present effort in Congress to put huge sums of money into synfuels from coal as against developing ethanol, and I think that there is every reason to exclude Mobil from objective scientific work in this area.

Senator McGovern. That is precisely what led Congressman Bedell and I to send a letter to Secretary Duncan about 6 weeks ago urging him to dismiss five of the nine members on that biomass panel because they are the five that served on the gasohol study group, two of them either consultants or employees of the Mobil Oil Co., and I just think it's incredible that an important agency of the U.S. Government that's making recommendations that affect all of us would be loaded the way that is. I don't say these are bad men or dishonest men. It's just that they are serving their employer, and doubtless serving him very well; namely, the Mobil Oil Co.

I'm accused in the ad that they ran of serving farmers of South Dakota. I admit that. I think I'm here for that purpose. I admit my bias, but I'm not on the study group that's making recommendations on national policy affecting everybody else. I happen to think it's in the interest of the entire country that we have a farm-based, small-scale gasohol development program. I think that's democratic with a

small d. I think it's sound economics. I think it will enhance the fuels supply in the country. But I don't make any bones about the fact that I'm working for the farm people of South Dakota. They sent me here to the Senate for that purpose and I don't see any conflict between that and the public interest as long as I bring some reasonable degree of balance to my judgment.

But I very much hope that Secretary Duncan, who I happen to think is a good man and a very capable man, will consider seriously the plea that Congressman Bedell and I have made, which we repeat here today, that he dismiss these people; not because they are bad people, but because they at least suffer the appearance, if not the actuality, of a bias that favors the big oil companies over the family farm production of this country.

Mr. COMMONER. I support that. As a matter of fact, it would be an important precedent because, speaking now as a member of the scientific community, I find that there's an increasing tendency to mix profitmaking with science. I think it's unfortunate, for example, that you find in the area of genetic engineering basic scientists suddenly turning up as directors of corporations that are going to exploit that basic work.

As a matter of fact, I think you would be taking a step that would serve as a very important warning to the scientific community to look carefully to their objectivity and the importance of maintaining a position of no economic gain.

I have always followed the rule in our work to have no association with any commercial enterprise that deals with research in which I have been involved, simply as a matter of what I would call scientific morality, and I must say that I have been distressed in recent years in seeing that idea diminished partly by the kinds of things that you have been observing, but now even on the initiative of scientists themselves.

Senator MCGOVERN. Thank you very much, Mr. Commoner. I had indicated earlier that we might meet with the press following this meeting, but I see we are running into a series of rollcall votes here and I think that's not going to be possible, but I believe we have made the essential points here in any event that we wanted to make for the public, and I think I will yield now to Congressman Bedell who's followed this whole matter as closely as anybody I know in the Congress.

Representative BEDELL. Thank you, Senator McGovern. I want to again thank the whole panel for being here.

Mr. Stelson, have you had anything to do with the work that DOE has done with Mobil in regard to their process of converting methanol to high ethylene gasoline?

Mr. STELSON. No, I have not.

Representative BEDELL. Are you acquainted with what has happened in that regard?

Mr. STELSON. Casually, yes.

Representative BEDELL. Are you aware of the fact that, first of all, Mobil had a patent on the process or catalyst for a process of converting methanol to high octane gasoline? First of all, to improve that process, the taxpayers paid for the cost of such a pilot plant in New Jersey, to prove that the Mobil process would work satisfactorily.

Mr. STELSON. I'm not familiar with that program specifically, no.

Representative BEDELL. Let me get into it, because that's the first part. The second part is that now the Department of Energy has entered into a contract with the Government of Germany, with Mobil, and with two German firms, in which the taxpayers are putting up one-third of the cost for a plant to be built in Germany. The German Government is putting up one-third of the cost. The two German firms are putting up part of the cost and Mobil is putting up none of the costs; Mobil is furnishing the catalyst for the process.

If I can read part of the contract, it says that we have such a situation. Let me read to you.

> Mobil shall have the first option to file patent applications for any resultant patents at its private expense, and such patent applications and patents shall be the property of Mobil for the benefit of the contracting parties Mobil * * * in accordance with and subject to licensing requirements and other requirements of this and--

what we're saying is that the taxpayers are putting up a third of the money, that the German Government is putting up a third of the money, and Mobil is putting up the catalyst which they have, and then we say any resulting patents as a result of that effort will go to Mobil Oil Co.

Do you think that sort of contract would be a normal contract that you would expect to see out of the Department of Energy with an oil firm or with any other firm?

Mr. STELSON. I wouldn't know. I would have to have much more detail. We are interested in domestically produced fuels, including methanol, to reduce oil imports; and if this is a system of doing that, I can well believe that it's such a project.

Representative BEDELL. And you feel the taxpayers ought to do that because Mobil would not be able to afford to prove their own patent, I assume?

Mr. STELSON. Again, I don't know any of the details.

Representative BEDELL. Do you know what their profits were in the first quarter of 1980?

Mr. STELSON. No, I don't.

Representative BEDELL. I can tell you. Their profits were $1.381 billion in one quarter. If you want to compute that out as to just how much it amounts to, that means if it continued and if that were the average for the year, that would mean for the average family of five, every family of five in the United States, it would be equivalent to $100 that they would pay in profits to Mobil or $2 a week of every family of five to go to Mobil Oil. So I suppose it does make a little sense that the taxpayers then also pay the cost of trying to prove Mobil patents so Mobil would have control of this process if indeed it works out? Is that the attitude in the Department of Energy? I don't think the issue is the ERAB report or what it showed.

I think the issue is who's running the U.S. Government and who it's being run for, and if it's the Department of Energy's belief that it is in the interest of the taxpayers that the taxpayers should pay the money to prove a Mobil process which will give them control of the conversion into high-octane gasoline and then tell them they would get all the patents and we would do it in Germany; at the same time they have entered into a contract according to news reports, the $380 million for

this project in New Zealand, it's waving some awfully big red flags for the people of the United States as to who it is that's making the decisions and how the decisions are made at the Department of Energy. And on top of the situation, we see in the ERAB report that, as the Senator so clearly pointed out, we have a Mobil person on a board of seven and a consultant who has consulted with Mobil as the chairman of the board. With all of these various discrepancies that are in that report, I don't see how the people of America can help but question whether we have a Department of Energy which is working for the interest of the American public or whether it's working for the interest of Mobil Oil Co.

How would you answer that question of your constituents, when these are the facts? These are the profits. This is the contract that we have entered into with them. I don't think anybody questions any of the facts.

Mr. STELSON. As I said——

Senator MCGOVERN. If you could just hold a moment, Congressman Bedell, as those five lights indicate, we are halfway through a rollcall. May I turn this gavel over to you?

Representative BEDELL. Delighted, Senator.

Senator MCGOVERN. I think you're doing very well here and if you would close this hearing at the appropriate point I would appreciate it. We are going to have a series of rollcalls that will keep me away. Thank you very much, and thanks to all the witnesses.

Representative BEDELL [presiding]. Thank you Senator. Please continue Mr. Stelson.

Mr. STELSON. I would be glad to find out those details and look into it if you would like me to do so.

I would like to point out, though, that this country purchases about $90 billion a year of foreign oil. This is an enormous burden on the United States. There are a multitude of programs to develop internal liquid fuel capabilities and energy capabilities to displace this tremendous outflow of funds for the purchase of oil, and I think the Department of Energy's mission is very clear. It's our job to move as rapidly as possible from an oil-dependent economy to a diversified energy economy. We need to develop the maximum number of options, and the best possible options, so this country can be strong in energy systems.

I know nothing about the particular option that you describe. I would be glad to look into it.

Representative BEDELL. But does that really help our option to have the Federal Government pay the cost of proving this process in Germany, and then saying that one of the oil companies will control all those patent rights? That really makes it a lot better for the American people and gives us a lot more control of our own energy future, for Mobil Oil to own the patent rights and be in a position to pretty well control what we do with that process, don't you think?

Mr. STELSON. The critical aspect, having worked extensively in patents and patent rights, is not who owns the patent rights but how it's licensed. For example, frequently in Government research we retain in the Government royalty-free license for Government activities, but the Government is not in commercial development and generally it isn't in the patent licensing business. So although somebody else re-

tains the patent, licensing conditions are the most critical factor of the arrangement.

We often on our contracts insist on favorable licensing conditions so that that technology will move into commercialization very rapidly.

Representative BEDELL. And so I take it the Department of Energy thinks that if you were to get a patent on the process that could help solve our energy problems, the public interest would be better served if that patent were owned by one individual oil company than if that patent were available for the public so that it could be used by anybody without restrictions? Is that the feeling of the Department of Energy?

Mr. STELSON. It's generally been shown that patents are a constructive mechanism for the development of economic systems that help the country. The critical aspect is what the controls are with respect to the patent in its licensing. The Government is not in the licensing business. Typically, commercial organizations of one kind or another do license patents and the conditions very widely.

Representative BEDELL. This is very, very important because, if I understand your testimony—and I think I do—you believe that indeed it is in the best national interest in terms of getting a process to move forward in our society if there are patents that are owned by one individual firm as compared to a situation where those patents are owned by the Government and made available to everybody. Apparently that is your opinion because that's pretty important. If that's the attitude of the Department of Energy, I think it's pretty important.

Mr. STELSON. It's not the attitude of the Department of Energy.

Representative BEDELL. If it's not the attitude of the Department of Energy, would you understand why it wouldn't be the Government entering into a contract in which they put up the money and then assigning all the patent rights to Mobil Oil Co., who only put up the catalyst for the whole procedure?

Mr. STELSON. Were there any licensing clauses in the contract?

Representative BEDELL. The contract provides for licensing under reasonable terms, and I talked to some people who told me that that means if you wanted the license from Mobil and they gave you a license and said you must pay $10 a gallon for this process, the choice would have to be to go to court with Mobil. I presume you believe that most people would have the opportunity to go to court with the Mobil Oil Co., with all their lawyers, and try to see if you can get an opportunity to use that patent if you felt the terms were unreasonable?

Mr. STELSON. It's definitely the policy of the Department of Energy to move to diversify domestic energy resources, and so the details would have to be consistent with making the technology widely available for production in this country. That's the typical policy position. Again, I know nothing of the details on this contract. I would be glad to look into it or to have others who are responsible for it look into it.

[The following information was subsequently supplied for the record:]

The following facts are provided for the record in response to several questions asked about a Department of Energy agreement with the Federal Republic of Germany (FRG) that will result in construction and operation of a fluidized bed methanol-to-gasoline (MTG) pilot plant.

It should be noted that this is a bilateral agreement between the two governments with industrial participation by both Mobil Oil and two German firms.

The Department of Energy does not have a contract with either Mobil or the German firms; rather, the contracts are between Mobil and the West German firms. Under the terms of the bilateral agreement with the FRG, DOE's share of the cost to construct this pilot plant will be one-third of the total; the FRG's share will be one-third; two German industrial firms would share the remainder of the cost and Mobil Oil would provide the catalyst.

The agreement to build this pilot plant is an outgrowth of work already done on a cost-sharing basis by Mobil and DOE's predecessor, the Energy Research and Development Administration. That work involved a laboratory demonstration unit with a maximum output of a 4 barrels per day of gasoline. The current project is a scale-up to a 100 barrel per day demonstration unit. Based on this follow-on project, the key scaling relationships and engineering data base needed to design a commercial size fluidized bed methanol-to-gasoline production facility should be developed.

While it is true that Mobil is providing only the catalyst for the current project, the MTG process is based on the Mobil catalyst, and this catalyst is absolutely essential to it. This catalyst was developed by Mobil entirely at its own expense, and Mobil already holds the patent for it. At present, there are not sufficient catalysts on hand for the demonstration unit being built in Germany, and Mobil has agreed to expend approximately $7 million to build a catalyst production facility to provide the catalysts needed for this project. The catalysts and production facility being funded by Mobil have no other use except fluidized bed methanol-to-gasoline projects. They cannot for example, be used in Mobil's fixed-bed MTG production facilities in New Zealand.

The following very brief summary of DOE patent policy should shed some light on the patent rights granted to Mobil under this agreement. DOE's general policy regarding patent rights arising from DOE-sponsored research, development and demonstration work is set forth in Section 9 of the Federal Nonnuclear Energy Research and Development Act of 1974 (Public Law 93–577). Under this authority, DOE takes title to such inventions but, in appropriate circumstances, may waive this right, thus, permitting private ownership of the patent rights. An objective as stated in Public Law 93–577 is that permitting private ownership of the patent rights can contribute to making the benefits of the program available to the public in the shortest practical time. A second objective is to promote the commercial utilization of such inventions. One of the important considerations involved in determining whether a waiver is appropriate is the extent to which the waiver recipent has made or will make a substantial investment of financial resources or technology developed at the contractor's private expense which will directly benefit the work to be performed.

The above considerations were factored into the decision that granted Mobil patent rights on new ideas evolving from this project. However, as noted earlier, the current project is a scale-up demonstration of the process for which Mobil already has patent rights; therefore, it is extremely unlikely that any broad patentable ideas would evolve from this project.

While Mobil does receive patent rights under the agreement, that same agreement requires Mobil to share royalties with the U.S. Government from licensing the process in the United States until twice the U.S. Government contributions are paid back. This obligation includes royalties from licensing of all of Mobil's patents on the process including any that it has obtained at private expense. Mobil catalyst patents are not included in this obligation since the catalyst was previously developed by Mobil at private expense, but Mobil has agreed to make the catalyst commercially available and to license its catalyst patents if it fails to do so.

While the DOE/FRG arrangement is an international agreement rather than an R&D contract governed by Public Law 93–577, the objectives and considerations contained in the policy of that statute permitting private ownership of rights from DOE-sponsored research were taken into account in the DOE/FRG agreement. The disposition of patent rights under that agreement is, therefore, in accordance with DOE's congressionally-mandated patent policy.

International cooperation in this type of project provides a number of technical and economic benefits, including eliminating unnecessary duplication of effort, gaining access to different technical approaches, obtaining more extensive technical contributions to particular efforts and sharing of advanced facilities and equipment. More specifically, this bilateral agreement provides the benefits summarized below:

1. The U.S. and Germany will mutually support energy projects, i.e., the FRG has agreed to provide 25 percent funding for an SRC–II demonstration plant to be built in Morgantown, West Virginia (the FRG share is expected to be approximately $375M).
2. The site chosen in Germany is unique and reduces costs. The plant is to be built at a site containing a methanol complex (for feed), refinery (for disposing of products and wastes and supplying utilities), and research center (for technical support).
3. DOE's share of the cost is only ⅓, yet the United States will obtain full economic evaluation of the process, together with the design and engineering data necessary for building even larger commercial-size plants in the U.S.
4. DOE get rights to build and operate royalty-free research, development or demonstration fluidized bed MTG plants.
5. Mobil has agreed to reimbursement of 200 percent of DOE contributions from future U.S. process royalties.

Representative BEDELL. It's right here if you want a copy of it. The details are pretty clear, at least as far as I'm concerned.

You see, first of all, we have an ERAB report wherein, as I understand from someone from the Department of Energy, there was a request that somebody be added to that board, who would have some knowledge of on-farm alcohol production.

Mrs. HOBSON. Yes.

Representative BEDELL. Do you have knowledge of that?

Mrs. HOBSON. Yes. Our office did request of the ERAB staff that a person be added because we were concerned about the imbalance of an unchartered subgroup who had knowledge, who had actual experience. Gene Schroeder, I think, was the person from the American Agricultural Movement.

Representative BEDELL. And as I understand, he was not added?

Mrs. HOBSON. Yes, we were not added.

Representative BEDELL. And I understand, Mr. Scheller, the report that you submitted was lost, so they said, and it was not included in what was done in the report?

Mr. SCHELLER. That's correct.

Representative BEDELL. I understand further that you only attended one of the meetings that they had.

Mr. SCHELLER. Well, the one 2-day meeting that the study group had I attended, yes.

Representative BEDELL. And I at least, for one, know of your knowledge in this particular area. Do you see the problem that I see in this? It's not the ERAB report. I'm disappointed. I think it has a lot of mistakes in the report and it ought to be corrected. We need to look at how that board was appointed, who was on the board, what the new board is, and how they operated—they didn't even appoint people who have knowledge of some of these opportunities—the report that was given by a person who did have knowledge of alcohol was lost, the contract that they enter into with Mobil Oil Co. which says that you don't have to put up any of the money—in all fairness, they said, if this works we will expect you to pay back twice your costs based upon a percentage of the royalties you get. That's a no-lose situation for Mobil Oil. And if we agree that Mobil Oil is so destitute that it wouldn't have happened if we hadn't done this—if we look at all those situations, it seems to me, anybody serving in the Government or anybody in our society would have to ask how the Department of Energy is operating in re-

gard to solving our problems and do we really believe that if we turn this over to Mobil Oil and let them have control of how these things are done that our energy problems are going to be pretty well solved?

I think my constituents do not particularly believe that that would be the best way to solve this particular problem, and if that's the way it's happening in the Department of Energy, then I think there are very serious concerns. And that's the red flag that I think we have here, and not whether or not there's a positive or negative energy balance or whether or not the economics are good or bad or all of these sorts of things.

It appears to me that somebody had better address the issue of whether we have Government of, by, and for the people in this country of ours, or whether we have Government of, by, and for Mobil Oil and the other big special interests that may have something to gain for themselves, which at least I believe frequently is not in the best interest of our national society.

Mr. POTTS. Congressman Bedell, I would not speak up to defend Mobil or the Department in the specifics of this case because I haven't read the contract myself, but I would like to make an argument that the Department of Energy is trying very hard to produce results for this country. We are using every method we can. We may make mistakes. Very possibly this could have been a mistake or intentional, because you have to realize that we have a need to bring the technology to the table. We need to bring the technology that has been produced by our energy companies to the table so we can use them for the good of this country.

You will realize, as a businessman yourself, that these are negotiated arrangements. In this particular arrangement, we may not have had the most adequate or the best advantage. But what you have to realize is that we are trying to encourage our energy companies in the United States to invest their future in energy rather than into, say, department stores or container companies.

In order to do that, sometimes we have to negotiate arrangements which may not be, for the single arrangement, what one would consider, as an outside observer, the very best potential deal that we could negotiate; but we are trying very hard to bring these to the table for the good of the country.

Representative BEDELL. Yes, and I have no argument with that, Mr. Potts, but one of the things I do argue with is some of the practices. I have been over to the Department of Energy two or three times in the last few weeks, because I have real problems with their personnel policies. It appears to me that people can come to work if they want to and don't need to come to work if they don't feel like it and yet, they can get their pay. One of the people I talked to over there, in regard to patent rights, said that sometimes they do negotiate but, that "we have a rule that we never grant patent rights to anybody unless they put up at least 30 to 60 percent of the amount of money." I haven't checked this out, however. Even if you take the value which they put on the Mobil catalyst, it doesn't come close to that sort of investment.

So apparently this was done differently than would normally be done by most companies. That's the concern I have. I have no concern that you're trying to solve the energy problem. My belief is if you

turn it over to Mobil Oil, it's going to be solved to the benefit of Mobil Oil rather than to the benefit of our Nation. That doesn't mean they are bad people. That's the way society operates. I don't think Mobil Oil people are apologizing to their stockholders for the fact that they made $1.3 billion in the first quarter of 1980. That's their goal. They did a tremendous job for their stockholders.

But there's no question that they would benefit better by having a patent to control all of our liquid fuel in these United States than if they didn't have such a patent, and they have the benefit by having all of our liquid fuel made by their company. That's just the fact of the matter.

It's hard for me to understand why the Department of Energy would do things differently with them than apparently they do with other groups. Do you understand my concern?

Mr. POTTS. Yes, I understand your concern.

Representative BEDELL. That's the concern I have.

Mr. Mavis, the advisory board members are quite vehement in their defense of their position on small-scale production. Yet in the December 11 meeting Mr. Pimentel is quoted as saying, "We tossed them in because there are a lot of people who are really enthused about them." These are the small-scale people. As one of the people really enthused about them, Mr. Mavis, I wonder what you think about the level of scientific objectivity in this report which has a line of small scale which belittles their near-term role in this whole effort.

Mr. MAVIS. You know, if you go back to this Mobil thing for a moment, back in the country where I come from, we call it putting the dog in the butcher shop. You've got the man who needs a product and he's got a total grip on the whole thing.

The small-scale technology is much further down the road than the ERAB report addresses and as most people understand. What has been missing—and you and I both know—has been some decent funding sources that would allow these plants to move forward. Plants have been able to come online at a very low cost per gallon and produce large volume. It's things like the ERAB report that causes the bankers and the people that we must deal with every day to withdraw their funds and sit and wait. We are in a position to turn our small plants into large plants. Our little plants are turning out 250 million gallons per year.

The impact of this whole thing, if you look at what Mr. Commoner has said, the thing people don't understand is this protectionist system in America is such that even under set-aside programs and severe economic situations for the farmers we have this erosion factor. A Nebraska test shows that a half pound of protein comes out of the mash that's left which will produce the same pounds of beef as a pound of soy meal, and those are the economic things.

So I look for a major spurt if we could simply get some of the funds from DOE out in the country that would really do good. The $10 million to Germany would build 40 plants of our size and produce about 70 million pounds of feed.

Representative BEDELL. Apparently you at least believe it can make a big contribution in the agricultural area.

Mr. MAVIS. Not only in agriculture, but in the small communities, the price of fuel in the small communities as this thing develops.

Representative BEDELL. I would like to have the letter of May 2 which Senator McGovern and I sent to Secretary Duncan entered in the record. It had 12 specific questions in it. The letter was returned to us. They did not answer the 12 questions, but I think they thought it might placate us a little bit. I would like to enter in the record both our letter and the reply from the Secretary. We certainly will contact the Secretary to see what a Senator and a Congressman have to do in order to get some answers to some questions that we have.

[The letters referred to follow:]

CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
Washington, D.C., May 2, 1980.

Hon. CHARLES W. DUNCAN,
Secretary of Energy, Department of Energy, Washington, D.C.

DEAR MR. SECRETARY: We are writing to advise you of our concerns regarding the recent issuance of the report of the Energy Research Advisory Board (ERAB) on Gasohol prepared by the Gasohol Study Group. We are confident you will agree with us that the manner in which this Board was appointed, in which it conducted its evaluation, and in which the public comment meeting was conducted, further reinforces the doubts about its findings, which we believe are grossly inaccurate.

Already, press reports in our area have referred to the Board's work as a "federal study", thereby granting the draft report a degree of legitimacy in the eyes of many who will view the report as a product of the Department of Energy. We believe that it is imperative that it be made clear that this was not a DOE effort, and that an assessment be made immediately of the Board's conduct of its inquiry. We therefore respectfully request the following:

(1) What amount of funds, including personnel costs, was provided to the Energy Research Advisory Board in fiscal year 1979 and 1980, and how much is proposed for fiscal year 1981?

(2) Please identify dates and locations of ERAB and sub-groups meetings in fiscal year 1979 and 1980, and provide a membership list, including alternates, for each subgroup, with each member's affiliation.

(3) How many man-years of DOE/ERAB staff time is devoted to ERAB, and which DOE personnel are involved in working with ERAB?

(4) Which contractors provided support and services for ERAB activities? If possible, please provide a copy of these contracts.

(5) Please list the total funding provided by DOE to Cornell University, Georgia Tech, Bell Laboratories and General Electric in fiscal year 1979 and 1980.

(6) Please provide transcripts for all ERAB and sub-group meetings where biomass was discussed.

(7) Who appointed the ERAB Gasohol Sub-group?

(8) Please provide a list of title and dates for all reports submitted by ERAB or its subgroups.

(9) Have any ERAB meetings, functions or gatherings been closed to the public? If so, which?

(10) Who called the May 1 ERAB meeting? Who was invited?

(11) Please provide general background on the ERAB. When was it formed, when does it expire, etc.?

(12) What, if any, policy role does ERAB have?

We appreciate your prompt attention to this request, Mr. Secretary, and look forward to your response.

Sincerely,

GEORGE MCGOVERN,
U.S. Senator.
BERKLEY BEDELL,
Member of Congress.

THE SECRETARY OF ENERGY,
Washington, D.C., June 16, 1980.

Hon. BERKLEY BEDELL,
House of Representatives,
Washington, D.C.

DEAR MR. BEDELL: This is in response to your letter regarding the Gasohol Study Group and the Biomass Panel of the Energy Research Advisory Board. The Board is an independent, scientifically-oriented group that advises my Office. It is one of many sources of advice used by the Department and its reports do not represent official Department of Energy policy. The members of the panels and study groups of the Energy Research Advisory Board are selected to provide balanced expertise on relevant technical issues. The recommendations forwarded by the panels are reviewed by the twenty-six member Energy Research Advisory Board. The broad range of experience represented on the Board further insures that the recommendations of a particular panel are reviewed from diverse perspectives.

The Report on Gasohol prepared by the Gasohol Study Group of the Energy Research Advisory Board is a broad overview of gasohol options available now and after 1985. The report does not advocate one form of alcohol production over another. Rather, it reviews the advantages and disadvantages associated with each form of alcohol production.

I assure you that the Department is not drifting toward a policy of rejecting on-farm and rural community-based alcohol production facilities. The Gasohol Report specifically recommends further study of small scale on-farm alcohol production and utilization. The report did not go into a great deal of detail on this issue because the Study Group lacked sufficient technical data on small scale production to incorporate a detailed discussion of this issue. The issue of small scale self-sufficiency for rural America currently is being studied by the Biomass Panel of the Board. The Biomass Panel is seeking scientific and technical information on small scale alcohol fuel production from all sources.

Your letter questions the composition of the Biomass Panel of the Energy Research Advisory Board. This Panel is a technically-oriented advisory group that provides one source of advice to the Department on Biomass issues. Each member of the Biomass Panel was selected to provide a balance of scientific disciplines crucial to its work. The Panel's meetings are open to the public and the Panel has sought and will consider technical and scientific information from all sources. Finally, the recommendations of the Panel will be reviewed by the Energy Research Advisory Board. For these reasons and because the checks and balances of the advisory process assure that the Board's recommendation will be as objective as possible, I do not believe it is necessary to replace any of the members of the Biomass Panel.

In particular, I believe your concerns about Dr. Pimentel may be based on incomplete information. Dr. Pimentel is a highly respected agricultural scientist who has devoted his career to helping the farmer improve agricultural practices. He has stated that he has never published any views opposed to alcohol fuels, nor does his relationship with Mobil Oil seem suspect. In 1979 Mobil Oil undertook a review of an agricultural system prepared by Dr. Barry Commoner's organization. Mobil Oil awarded Dr. Commoner's organization a grant of $7,500 to submit and review relevant data pertaining to this system. In addition, because Mobil Oil had no in-house expertise in the agricultural field, Dr. Pimentel was asked to assist with this review. Dr. Pimentel stated that he agreed to assist Mobil Oil only in the capacity of an independent consultant. He served in that capacity for 4½ days in the time period July to November, 1979. Based on this information, I would not consider Dr. Pimentel's activity a conflict of interest.

You know that I am personally committed to alcohol fuels. Since I took office as Secretary of Energy, the Department has moved aggressively in encouraging alcohol production from all sources. This advisory panel is composed of members with diverse views on alcohol fuels. I believe the diversity of the members' views will combine with the operation of the advisory process to give the Department and the public another valuable perspective on alcohol fuels.

Sincerely,

CHARLES W. DUNCAN, Jr.

Representative BEDELL. Are some of those letters answered by other than the people in the Department? Are there consultants hired to do some of this letter answering? Is that accurate or don't you know, Mr. Stelson?

Mr. STELSON. I don't know. I know that I personally handle a lot of letters from Congressmen.

Representative BEDELL. And do you ever have consultants answer letters for you?

Mr. STELSON. Every letter is furnished to me by an employee of DOE who has program responsibility in the area of interest. I manage an area of 2,500 contracts and 20,000 grants, so I don't have the personal knowledge of all those details.

Representative BEDELL. You don't know whether some of your replies that went out with your name on them were written by consultants or written by employees of the Department of Energy?

Mr. STELSON. They come to me only through employees of the Department with whom I review the letters.

Representative BEDELL. My question is, Do you know whether those letters that went out with your signature on them were all written by Department of Energy employees or whether some of them were written by consultants, who were there to answer letters?

Mr. STELSON. I do not know the details. Some weeks I have as many as 500 letters. I do not personally write those letters. But in every case I talk with a Government employee who works for me and is responsible for preparing the letter.

Representative BEDELL. Your answer is that the people who report to you are responsible for seeing that the letters are prepared, but you do not know whether those letters are prepared by people in the Department of Energy or are prepared by outside consultants that are hired to answer letters?

Mr. STELSON. I know that people who work for me are instructed to prepare those letters.

Representative BEDELL. That's not my question.

Mr. STELSON. I do not check every letter in detail.

Representative BEDELL. That's not my question, sir. My question is, do you or do you not know whether the letters that go out from those people that report to you are written by people in the Department of Energy or whether at times they are written by outside consultants that are hired to write such letters? My question is, Do you know or do you not know whether that's the case?

Mr. STELSON. I do not know in detail.

Representative BEDELL. Fine.

Mr. STELSON. I don't follow each one from the beginning.

Representative BEDELL. So then, if the report is correct in the newspaper this morning, I think very possibly Secretary Duncan is not to be criticized so much for us sending a letter with 12 questions and getting a reply that doesn't answer any of the 12 questions. I suppose we should send it back and check to be sure that he answers the letter.

Mr. STELSON. I would be pleased to check on it.

[The following information was subsequently supplied for the record:]

In their jointly signed letters of May 2, 1980, and May 12, 1980, Congressman Bedell and Senator McGovern posed several questions concerning the Gasohol Study Group, the Biomass Panel and the operations of the Energy Research Advisory Board. Those questions were answered in a June 16, 1980, letter signed by Charles Duncan, Secretary of the Department, and a July 11, 1980, letter signed by Edward A. Frieman, Director of Energy Research. Both letters were prepared by Federal employees, not by contractors.

THE SECRETARY OF ENERGY,
Washington, D.C., June 16, 1980.

Hon. BERKLEY BEDELL,
House of Representatives,
Washington, D.C.

DEAR MR. BEDELL: This is in response to your letter regarding the Gasohol Study Group and the Biomass Panel of the Energy Research Advisory Board. The Board is an independent, scientifically-oriented group that advises my Office. It is one of many sources of advice used by the Department and its reports do not represent official Department of Energy policy. The members of the panels and study groups of the Energy Research Advisory Board are selected to provide balanced expertise on relevant technical issues. The recommendations forwarded by the panels are reviewed by the twenty-six member Energy Research Advisory Board. The broad range of experience represented on the Board further insures that the recommendations of a particular panel are reviewed from diverse perspectives.

The Report on Gasohol prepared by the Gasohol Study Group of the Energy Research Advisory Board is a broad overview of gasohol options available now and after 1985. The report does not advocate one form of alcohol production over another. Rather, it reviews the advantages and disadvantages associated with each form of alcohol production.

I assure you that the Department is not drifting toward a policy of rejecting on-farm and rural community-based alcohol production facilities. The Gasohol Report specifically recommends further study of small scale on-farm alcohol production and utilization. The report did not go into a great deal of detail on this issue because the Study Group lacked sufficient technical data on small scale production to incorporate a dettailed discussion of this issue. The issue of small scale self-sufficiency for rural America currently is being studied by the Biomass Panel of the Board. The Biomass Panel is seeking scientific and technical information on small scale alcohol fuel production from all sources

Your letter questions the composition of the Biomass Panel of the Energy Research Advisory Board. This Panel is a technically-oriented advisory group that provides one source of advice to the Department on Biomass issues. Each member of the Biomass Panel was selected to provide a balance of scientific disciplines crucial to its work. The Panel's meetings are open to the public and the Panel has sought and will consider technical and scientific information from all sources. Finally, the recommendations of the Panel will be reviewed by the Energy will be reviewed by the Energy Research Advisory Board. For these reasons and because the checks and balances of the advisory process assure that the Board's recommendations will be as objective as possible, I do not believe it is necessary to replace any of the members of the Biomass Panel.

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You know that I am personally committed to alcohol fuels. Since I took office as Secretary of Energy, the Department has moved aggressively in encouraging alcohol production from all sources. This advisory panel is composed of mem-

bers with diverse views on alcohol fuels. I believe the diversity of the members' views will combine with the operation of the advisory process to give the Department and the public another valuable perspective on alcohol fuels.

Sincerely,

CHARLES W. DUNCAN.

DEPARTMENT OF ENERGY,
Washington, D.C., July 11, 1980.

Hon. GEORGE MCGOVERN,
U.S. Senate,
Washington, D.C.

DEAR SENATOR MCGOVERN: This letter is in response to your inquiries regarding the operation and activities of the Energy Research Advisory Board. Most of the information requested in your letters of May 2 and May 12 has already been transmitted to you via past correspondence or through direct communications with your staff. I believe information contained in the enclosure represents the balance of it. If you require additional information, your staff may wish to contact Dr. Thomas Kuehn, Executive Director of the Energy Research Advisory Board on 252-8933.

Sincerely,

EDWARD A. FRIEMAN,
Director of Energy Research.

Enclosure.

INFORMATION PERTAINING TO THE ENERGY RESEARCH ADVISORY BOARD

Question. What amount of funds, including personnel costs, was provided to the Energy Research Advisory Board in fiscal years 1979 and 1980, and how much is proposed for fiscal year 1981?

Answer. Expenditures for Calendar Year 1979 were $281,000; the budget ceiling for Calendar Year 1980—$506,000; 1981—$950,000.

Question. Please identify dates and locations of ERAB and subgroup meetings in fiscal years 1979 and 1980, and provide a membership list, including alternates, for each subgroup, with each member's affiliation.

Answer.

ERAB MEETINGS IN FISCAL YEAR 1979

Date	Name	Location
Nov. 9-10, 1978	Full Board	1E-235, FRSTL., Washington, D.C.
Feb. 1-2, 1979	do	National Academy of Sciences, Washington, D.C.
Mar. 1, 1979	ERAB Study Group	Lawrence Livermore Laboratory, Livermore, Calif.
Mar. 2, 1979	do	Berkeley, Calif.
Mar. 20, 1979	do	Los Alamos Scientific Laboratory, Los Alamos, N. Mex.
May 3-4, 1979	Full Board	National Academy of Sciences, Washington, D.C.
June 4-5, 1979	Gas Research Institute Program Review Study Group.	Gas Research Institute Conference Room, Chicago, Ill.
June 27, 1979	do	Room P11, 400 1st St., Washington, D.C.
Aug. 13-16, 1979	Full Board	Naval War College, Newport, R.I.

FISCAL YEAR 1980 (TO DATE)

Nov. 1-2, 1979	Full Board	7E-069, FRSTL, Washington, D.C.
Dec. 7, 1979	Geothermal Energy Subpanel	Republic Geothermal, Inc., Santa Fe Springs, Calif.
Dec. 10-11, 1979	Gasohol Study Group	7B-058, FRSTL, Washington, D.C.
Feb. 5, 1980	Geothermal Panel	6E-069, FRSTL, Washington, D.C.
Feb. 7-8, 1980	Full Board	Do.
Apr. 14-15, 1980	Conservation Panel	6A-110, FRSTL, Washington, D.C.
May 1-2, 1980	Full Board	4A-104, FRSTL, Washington, D.C.
May 9, 1980	Biomass Panel	6A-110, FRSTL, Washington, D.C.
May 23, 1980	Fusion Study	Do.
June 7, 1980	R. & D. Panel	Do.

(A Full Board Meeting is planned for one week in August at LaJolla, California.)

Membership lists are attached.

Question. How many man-years of DOE/ERAB staff time is devoted to ERAB, and which DOE personnel are involved in working with ERAB?

Answer. Man-years—3. Thomas J. Kuehn, Executive Director; Eudora M. Taylor, Staff Assistant; Robert A. Weinraub, Executive Assistant.

Question. Please provide a list of titles and dates for all reports submitted by ERAB or its subgroups.

Answer.

Past activities	*Report dates*
Report of ERAB Study on Strategic Petroleum Reserve and Brine Disposal Problem.	January 1979.
Report of the ERAB on the relationship between the University of California and the Los Alamos Scientific and Lawrence Livermore Laboratories.	May 1979.
Report of ERAB Study Group for GRI Program Review.	July 1979
Report of ERAB Study Group on Construction/Development Project Management.	November 1979.
Report of ERAB Study Group to Evaluate the Proposed Coal Gasification Multi-Test Facility.	November 1979.
Report of the ERAB on Gasohol.	May 1980.
Report of the ERAB on High Temperature Resources Development.	May 1980.
Report of the ERAB on Hot Dry Rock.	May 1980.

ENERGY RESEARCH ADVISORY BOARD MEMBERSHIP

CHAIRMAN

Buchsbaum, Solomon J., Executive Vice President, Customer Systems, Bell Laboratories, Holmdel, N.J.

VICE CHAIRMAN

Fletcher, James C., University of Pittsburgh, PA.

MEMBERS

Bennett, Ivan L., Provost and Dean, New York University Medical Center, New York, NY.

Clewell, Dayton, Vice President, Ret., Mobil Oil, Darien, CT.

Cochran, Thomas B., Natural Resources Defense Council, Washington, D.C.

Compton, W. Dale, Vice President—Research, Ford Motor Company, Dearborn, MI.

Cooke, Lloyd M., Vice Chairman, Economic Development Council of NYC, New York, NY.

Dutton, Paul, Attorney-at-Law, Mitchell, Mitchell & Reed, Youngstown, OH.

Foster, John S., Vice President for Science & Technology, TRW Inc., Cleveland, OH.

Fubini, Eugene G., President, E. G. Fubini Consultants, Ltd., Arlington, VA.

Hackerman, Norman, President, Rice University, Houston, TX.

Hebeler, Henry K., President, Boeing Aerospace Corporation, Seattle, WA.

Hinman, Richard L., Vice President, Chemical Products R&D, Pfizer, Inc., Groton, CT.

Hitch, Charles J., President Emeritus, Univesrity of California, Berkeley, CA.

Kivelson, Margaret, Space Science Center, University of California, Los Angeles, CA.

Lovins, Amory, Friends of the Earth, London, England and San Francisco, CA.

McCormick, William, Vice President and Assistant to the Chairman of the Board, American Natural Resources Company, Detroit, MI.

Nye, Joseph, Professor, Center for International Affairs, Harvard University, Cambridge, MA.

Pimentel, David, Department of Entomology and Section of Ecology & Systematics, Cornell University, Ithaca, NY.

Reichl, Eric H., President, Retired, Conoco Coal Development Company, Greenwich, CT.

Roddis, Louis H., Consulting Engineer, Charleston, SC.

Savit, Carl H., Senior Vice President, Technology, Western Geophysical Company, Houston, TX.

Schmitt, Roland W., Vice President, Corporate Research and Development, General Electric Company, Schenectady, NY.
Thompson, Grant, Conservation Foundation, Washington, D.C.
Tschinkel, Victoria J., Assistant Secretary, Department of Environmental Regulation, State of Florida, Tallahassee, FL.

ERAB STAFF

Kuehn, Thomas J., Executive Director, Energy Research Advisory Board, Forrestal Building, M.S. 3F–032, Washington, D.C. 20585; Tel. 202/252–8933.
Taylor, Eudora M., Staff Assistant, Energy Research Advisory Board, Forrestal Building, M.S. 3F–032, Washington, D.C. 20585; Tel. 202/252–8933.
Weinraub, Robert A., Executive Assistant, Energy Research Advisory Board, Forrestal Building, M.S. 3F–032, Washintgon, D.C. 20585; Tel. 202/252–8933.

Fusion Study Group of the Energy Research Advisory Board

MEMBERSHIP

Buchsbaum, Solomon J. (Chairman),[1] Executive Vice President, Customer Systems, Bell Laboratories, Holmdel, N.J.
Conn, Robert, School of Engineering & Applied Science, University of California, Los Angeles, CA.
Fletcher, James C.,[1] University of Pittsburgh, Pittsburgh, PA.
Foster, John S.,[1] Vice President for Science & Technology, TRW Inc., Cleveland, OH.
Fubini, Eugene G.,[1] E. G. Fubini Consultants, Ltd., Arlington, VA.
Goldberger, Marvin, President, California Institute of Technology, Pasadena, CA.
Gould, Roy, Department of Physics, California Institute of Technology, Pasadena, CA.
Panofsky, Wolfgang, Director, Stanford Linear Accelerator Center, Stanford, CA.
Rosenbluth, Marshall, Institute of Advanced Studies, Princeton University, Princeton, NJ.

STAFF

Johnson, Thomas Major, Department of English, USMA, West Point, NY 10996; Tel. 914/938–2058.

Research and Development Panel of the Energy Research Advisory Board

MEMBERSHIP

Foster, John S. (Chairman),[1] Vice President for Science and Technology, TRW Inc., Cleveland, OH.
Bennett, Ivan L., Provost and Dean, New York University Medical Center, New York, NY.
Compton, W. Dale,[1] Vice President—Research, Ford Motor Company, Dearborn, MI.
Hackerman, Norman, President, Rice University, Houston, TX.
Roddis, Louis H., Consulting Engineer, Charleston, SC.
Schmitt, Roland W.,[1] Vice President, Corporate Research & Development, General Electric Company, Schenectady, NY.
Tschinkel, Victoria J., Assistant Secretary, Department of Environmental Regulation, State of Florida, Tallahassee, FL.

STAFF

Kuehn, Thomas J., Executive Director, Energy Research Advisory Board, Forrestal Building, 3G–092, Washington, D.C. 20585; Tel. 202/252–8933.

Geothermal Panel of the Energy Research Advisory Board

MEMBERSHIP

Savit, Carl H. (Chairman),[1] Senior Vice President, Technology, Western Geophysical Company, Houston, TX.

[1] ERAB members.

Aidlin, Joseph (Magma Power Company), Los Angeles, CA.
Butler, David, Chevron, Inc., San Francisco, CA.
Dolan, William M., Manager, Geothermal Branch, Amax Exploration Inc., Wheat Ridge, CO.
Ewen, Lois, Coronado, CA.
Hunt, Herbert, Eugene Water and Electric Board, Eugene, OR.
Keller, George, Department of Physics, Colorado School of Mines, Golden, CO.
Lund, John, Geo-Heat Utilization Center, Oregon Institute of Technology, Klamath Falls, OR.
McNamara, Jack, Attorney-at-Law, Los Angeles, CA.
Otte, Carel, Geothermal Division, Union Oil Company of California, Los Angeles, CA.
Pool, Richard, Kaiser Aluminum and Chemical Corp., Oakland, CA.
Rex, Robert, President, Republic Geothermal Inc., Santa Fe Springs, Ca.
Roberts, Vasel W., Program Mgr., Geothermal Power Systems, Electric Power Research Institute, Palo Alto, CA.
Tschinkel Victoria J.,[1] Assistant Secretary of Environmental Regulations, Tallahassee, FL.
Ward, Stanley H., Department of Geology & Geophysics, University of Utah, Salt Lake City, UT.

ERAB STAFF

Weinraub, Robert A., Energy Research Advisory Board, Forrestal Building, GE–216, Washington, D.C. 20585; Tel. 202/252–8933.

GAS RESEARCH INSTITUTE STUDY GROUP OF THE ENERGY RESEARCH ADVISORY BOARD

MEMBERSHIP

Tschinkel, Victoria J. (Chairperson),[1] Assistant Secretary, Department of Environmental Regulation, State of Florida, Tallahassee, FL.
Clewell, Dayton,[1] Vice President, Retired, Mobil Oil Company, Darien, CT.
Dutton, Paul,[1] Attorney-at-Law, Mitchell, Mitchell & Reed, Youngstown, OH.
Giner, Jose, President, Giner, Inc., Waltham, MA.
Hinman, Richard L.,[1] Vice President, Chemical Products R&D, Pfizer, Inc., Groton, CT.
Reichl, Eric H.,[1] President, Retired, Conoco Coal Development Company, Greenwich, CT.

STAFF

Kuehn, Thomas J., Executive Director, Energy Research Advisory Board, Forrestal Building, GE–216, Washington, D.C. 20585; Tel. 202/252–8933.
Carter, William, Fossil Program Manager, Los Alamos National Scientific Laboratory, Mail Stop 329, Los Alamos, NM 87534; Tel. 505/667–6651.

CONSULTANT

Monetta, Dominic, Washington, D.C.

BIOMASS PANEL OF THE ENERGY RESEARCH ADVISORY BOARD

MEMBERSHIP

Pimentel, David (Chairman),[1] Professor, Department of Entomology and Section of Ecology & Systematics, Cornell University, Ithaca, NY.
Cooney, Charles, Department of Biochemical Engineering, Massachusetts Institute of Technology, Cambridge, MA.
Doering, Otto, Agriculture Economics Department, Purdue University, West Lafayette, IN.
Hinman, Richard L.,[1] Vice President, Chemical Products R&D, Pfizer Inc., Groton, CT.

[1] ERAB members.

Hudson, William, Manager of Market Research, % The Andersons, Maumee, OH.

Kivelson, Margaret G.,[1] Professor, Space Science Center, University of California, Los Angeles, CA.

Patterson, Donald, The Plains, VA.

Spurlock, Jack, Professor, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, GA.

Weisz, Paul, Director, Central Research Division, Mobil Research and Development Corp., Princeton, NJ.

STAFF

Weinraub, Robert A., Energy Research Advisory Board, Forrestal Building, GE-216, Washington, D.C. 20585; Tel. 202/252-8933.

CONSERVATION PANEL OF THE ENERGY RESEARCH ADVISORY BOARD MEMBERSHIP

Fletcher, James C. (Chairman), University of Pittsburgh, Pittsburgh, Pa.

Cochran, Thomas B.,[1] Natural Resources Defense Council, Washington, D.C.

Compton, W. Dale,[1] Vice President—Research, Ford Motor Company, Dearborn, Mich.

Jones, Trevor, Vice President—Engineering, TRW Automotive World-Wide, Cleveland, Ohio.

McCormick, William.[1] Vice President and Assistant to the Chairman of the Board, American Natural Resources Company, Detroit, Mich.

Morrison, Denton, Professor of Sociology, Michigan State University, East Lansing, Mich.

Roddis, Louis H.,[1] Consulting Engineer, Charleston, S.C.

Sant, Roger, Director, Mellon Institute, Arlington, Va.

Socolow, Robert, Center for Energy and Environmental Studies, Princeton University, Princeton, N.J.

Sternlight, David, Chief Economist, Atlantic Richfield Company, Los Angeles, Calif.

Thompson, Grant, Conservation Foundation, Washington, D.C.

Widmer, Thomas, Vice President—Engineering, Thermal Electron Corporation, Waltham, Mass.

STAFF

Taylor, Eudora M., Energy Research Advisory Board, Forrestal Building, GE-216, Washington, D.C. 20585; Tel. 202-252-8933.

Weinraub, Robert A., Energy Research Advisory Board, Forrestal Building, GE-216, Washington, D.C. 20585; Tel. 202-252-8933.

Representative BEDELL. Mr. Commoner, you had something to say I think.

Mr. COMMONER. Yes; I wanted to comment on the thrust of your remarks regarding the role of Mobil in making energy policy.

While I completely agree with you that the evidence indicates that Mobil's interest in making a profit is in conflict with the national interest, I think the issue goes beyond DOE responsibility, and if I may, I'd like to suggest that the Congress holds a responsibility here.

It seems to me that the big problem we've got in the energy issue, as well as in other aspects of our economy, is that the Congress has allowed its concern with maintaining private enterprise to establish a policy in which commercial enterprises are free to do whatever they want within the law to optimize their profits in the hope, which is now not realized, that it will benefit the country.

And I would like to suggest that the Congress needs to look very carefully in the area of energy into the question of establishing that energy will be developed and used in this country in the national interest and not in the interest of maximizing profits.

[1] ERAB members.

I think it may be better for this issue to be raised on a very broad scale in the Congress rather than look for defects in the DOE's procedures, because I think you will find exactly this same difficulty in the Department of Transportation.

At this moment the automobile industry is in the process of creating a revolution in the manufacture of cars. The so-called world car will have a great deal to do with the way in which we use energy. As far as I know, that decision is being made unilaterally by the automobile industry with no intervention on the part of the public; just as in the mid-1950's the oil companies of the United States cut back on exploration in the United States and went abroad, making us dependent on foreign oil.

In other words, what you're raising is a legitimate point, but I think it goes to the heart of the relationship between private enterprise and the national interest, and I think it would be a good idea to raise these issues on the floor of the Congress as well as before representatives of DOE.

Representative BEDELL. I appreciate that comment because I think it's right to the point, and in that regard I think we owe a debt of gratitude to all you people who have been here. As I indicated, I think we owe a debt of gratitude to the ERAB board because I think it helped to raise some red flags that needed to be waved.

I think that's part of the purpose of this hearing, Mr. Commoner—to help. Generally, what happens when Congress acts for the public is they question what is happening, and I think this hearing itself gave us an opportunity to at least raise some questions as to what is happening in our society. For that reason, I think we owe a debt of thanks to all of you that are here and certainly to Senator McGovern for calling these hearings.

If there's nothing further, I'm going to adjourn the subcommittee. Does anybody have anything they want to say?

[No response.]

Representative BEDELL. If not, the subcommittee is adjourned.

[Whereupon, at 1:05 p.m., the subcommittee adjourned, subject to the call of the Chair.]

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APPENDIX

FRIENDS OF THE EARTH FOUNDATION,
INTERNATIONAL PROJECT FOR SOFT ENERGY PATHS,
San Francisco, Calif., July 5, 1980.

Re Gasohol Report of ERAB.

Hon. CHARLES W. DUNCAN, Jr.,
Secretary, Department of Energy, Washington, D.C.

DEAR SECRETARY DUNCAN: On May 2, 1980, the Energy Research Advisory Board, of which I am a member, submitted to you a report by the Gasohol Study Group. ERAB Chairman Buchsbaum's letter of transmittal did not mention that ERAB's endorsement of the report was not unanimous. I, for example, had voted by proxy against its acceptance because I had not been sent the final draft, had received only two days' notice of the 1–2 May meeting at which ERAB adopted the report,[1] was therefore unable to attend, and could not tell whether my comments of 4 February 1980 on an earlier draft had been properly reflected in the final version. Although Dr. Buchsbaum had assured ERAB (8 Feb. transcript, p. 348) that the members would see the final draft before it was transmitted to you, and although I had asked for this specifically through my proxy, it was apparently transmitted to you immediately on its adoption on 2 May. ERAB never did send me a copy. Having now received one from another source, I find my 4 February comments were for the most part disregarded, and must therefore let you know directly, rather than through ERAB's usual process, why I think the Gasohol Report gives a seriously distorted picture of the potential of fuel alcohols. I do not know how far my own reservations reflect those of other members, since those of Dr. Tom Cochran, for example, are merely noted in the record without specifying what they were (8 Feb. transcript, p. 331).

The Office of Alcohol Fuels has saved me a good deal of trouble by its valuable review of the ERAB Gasohol Report. I agree generally with the thrust and (subject to a few minor exceptions) with the substance of the OAF review as regards both the strengths and the weaknesses of the ERAB report. I wish to emphasize in addition:

"Gasohol Energetics and Economics": Finding 1 (net energy): The flat conclusions stated do not reflect enormous ranges in the data. These ranges are even larger than those cited in Table 1: for example, while Table 1 assumes in-plant energy requirements of 69 kBTU/gal EtOH, based apparently on calculations for a large model plant, empirical values of 29 have been reported to make the 190-proof azeotrope (SERI citation in 1 May 1980 ERAB transcript, p. 154) or even to make anhydrous EtOH (Energy Consumer, January 1980, p. 13, USDOE). The other main energy input, 45 kBTU/gal EtOH for growing corn, is extremely sensitive to the assumed feedstock and farming method: the figure assumed is an average of standard high-energy farm practice, not best present practice. Taking differences and ratios between similar large numbers with severalfold uncertainties does not lead to the report's conclusions; it leads to indeterminate conclusions, and the report should so state. The only way to provide explicit results is by parametric treatment (as Chambers et al. did in Science 16 Nov. 1980).

It is very doubtful that the report assumes "best available technology" even for conventional oil- and gas-fired plants. But it is impossible to tell from the report what types of other technologies are considered. My 4 February 1980 com-

[1] I was notified by phone 29 April by Tina Hobson and a few hours later by Dr. Kuehn of ERAB. He says his staff tried to reach me by letters and calls much earlier; but they cannot have tried very hard. I sent them in February a detailed list of addresses and phone numbers (London to 28 February, then Germany to 4 March; Japan from 29 March and the US from 12 April). My offices had the same itinerary and used it successfully. All my mail was forwarded, and many people reached me in all those countries, but I received no ERAB mail or messages about the meeting.

ments had urged explicit attention, for example, to partial or complete alcohol/water separation by freezing (a virtually zero-cost method well suited to the Great Plains), by chemical extractants (e.g. Kendall Pye's work at U. Penn. on butanol slurries), by cellulosic absorption (e.g. Ludisch, Science 205:898, 1979), by hydrophobic plastics, by molecular sieves, and—experimentally—by synthetic membranes. Further, some conventional stills using solar or geothermal heat are already built or being built—e.g. in the San Luis Valley (Colorado), where private initiative has produced promising designs fed with cull potatoes and barley washings. The report cites none of these methods.

Even if the net-energy, conclusions drawn were justified, their obvious implication would be that the type of corn-ethanol system considered is in the same net-energy league as, or more favorable than, coal synfuel plants—but probably faster, simpler, cheaper, and less likely to make polyaromatic carcinogens.

Having set up the effort in the mid-70s by the International Federation of Institutes for Advanced Study (IFIAS) to establish generally agreed accounting rules for net energy analysis, I am well aware of the complexities and pitfalls of this type of work and of how easily it lends itself to abuse if not presented much more carefully than was done in ERAB's report.

Same section, Finding 4 (effect of process improvements): Corn is not the only nor, probably, the best feedstock. Currently popular ways of growing corn are not the only nor, probably, the best ways. Even if the 73 percent figure were right (which, with OAF, I doubt), the conclusion would be invalid. I suspect, with Senator McGovern, that feedstocks other than grains—and especially farm and forestry residues—deserve much more attention as feedstocks than do the cereal crops themselves. I also note with interest this passage on p. 45 of SERI's February 1980 report Fuel from Farms:

"A simple comparison of potential ethanol yield per acre of various crops will not rank the crops in terms of economic value for production of ethanol. The crops vary considerably in their demands on the soil, demands for water, need for fertilization, susceptibility to disease or insect damage, etc. These factors critically influence the economics of producing a crop. Fortunately, forage crops which have the potential for producing large amounts of ethanol per acre have specific agronomic advantages relative to some of the principal grain crops (e.g., corn).

"The nonfruiting crops, including forage crops, some varieties of high-sugar sorghum, and Jerusalem artichokes, are less susceptible to catastrophic loss (e.g., due to hail, frost, insects, disease, etc.), and, in fact are less likely to suffer significant loss of production due to adverse circumstance of any sort than are fruiting crops such as grains. Furthermore, forage crops and Jerusalem artichokes are less demanding in their culture than almost any grain. Their cost of culture is usually lower than for grains on the same farm, and they have great potential for planting on marginal land."

Subject to concerns (infra) about soil and water, we should be seeking to optimize both feedstocks and conversion processes, not regarding improvements in either as too small to be important.

Further, since this Finding concerns economics rather than energetics, it is worth emphasizing that what fuel alcohols have to beat is not the average gallon of gasoline but the marginal gallon, made from imported oil and bearing a private internal retail cost around $1.50–2.00: its social cost is far higher than that.

Same section, Finding 9 (cellulosic feedstocks): Cellulosic feedstocks, which I take to include those rich in lignin such as wood wastes, are indeed more abundant, more widely available, and generally cheaper than current crops. But I think much more can be done much faster than ERAB suggests, and was delighted to see in your 18 June 1980 remarks to the National Alcohol Fuels Commission an intention to accelerate this work. One would hardly guess from the ERAB report, for example, that Prof. Al Converse's experimental acid hydrolysis rig (Dartmouth College) was already producing over a year ago near-quantitative yields of glucose from newspaper and even from oak.

"Gasohol Impact on Food and the Environment," Finding 1 (grain availability): Please see Finding 4 above.

Same section, Finding 2 (competition with food): This finding (like Recommendation 3) is unsupported by an analysis. It may turn out that the improvement in farm cash-flow and the reduction in farm operating costs and vulnerability more than compensate as seen by the final food consumers. (Of course

changes in farm production costs, in either direction, are masked by the far larger costs between farm and retail consumer.)

Same section, Finding 3 (pressure on land) (likewise Recommendation 6): This issue is supremely important—I shall return to it below—but the finding as phrased seems to put most of the blame on gasohol production, not where it belongs—on unsound farming practices unrelated to gasohol.

Same section, Finding 4 (small-scale production): The tone of this Finding, and of the associated discussion on p. 14, is dismissive. No data or even estimates are presented. The scope of today's alcohol and other renewable activities at grassroots level, however, suggests that the cumulative effect of a myriad individually small contributions can be surprisingly large—to say nothing of the great local and regional importance of increased self-reliance in the farm community.

"Forestry and Agricultural Residues for Gasohol Production," Finding 1 (scope): The 27 billion gal/y figure (nowhere derived in the text) is probably far too low, even recognizing its restriction to one of many alcohols and pyrolysates available from this class of feedstocks. Please see below under "Feedstocks."

"Methanol Production from Coal," Findings 1 and 3 (costs) (also Recommendation 14): As was pointed out to ERAB in the 8 Feb. (pp. 317–8) and 1 May (p. 147) meetings, the coal/MeOH cost data assumed are badly out of date (from a 1978 SRI study). The discussion in the text (pp. 15, 22–3, 27) is vague and overoptimistic. It is highly unlikely that such a plant could be built for the cost assumed; the error in total cost may well be a factor two. The scale comparison is probably wrong in sign as well as in magnitude, especially if account is taken of the economic value of having a lead time of weeks to months (characteristic of alcohol plants up to 10^6 gal/y) rather than many years: this saves on interest, escalation, and risks arising from wrong forecasts of markets and technological change.

Same section, Finding 2 (problems using alcohols in cars): Extensive fleet tests in the US and Europe have shown how to solve these problems straightforwardly. Much of this knowledge has been available for decades: e.g. alcohol blends provided 18 percent of Europe's motor fuel and ran some 4 million cars in 1937. ERAB is skeptical about past-fleet tests (and perhaps about the utility of those now under way) and about the mechanical-equivalence hypothesis, but presents no convincing basis for its skepticism and leaves an impression of superficiality.

Same section, Finding 4 (coal/MeOH technology): This section applies a grossly asymmetrical test. Similarly encouraging statements could be made with greater force about biomass EtOH (and MeOH). Biomass-fed technologies appear to be available sooner and buildable faster.

Recommendation 11 (encourage coal/alcohol production): This does not follow even from the limited analysis given. To show that coal/alcohol production is worthwhile, one must show it is preferable to all other alternatives, including e.g. alcohols from woody materials and rapid improvements in vehicle efficiency (infra). That coal/MeOH may be cheaper in "future potential" than grain/EtOH does not mean it is cheaper than cellulosic alcohols. That is can be made in larger quantities does not mean those will be needed: I argued four years ago that cost-effectively efficient transport sector could run entirely on biomass-residue liquids without requiring any coal synfuels or conventional hydrocarbons. Whether a massive program of grain EtOH or of coal MeOH would be worse for food production—I suspect they are both a bad idea economically and ecologically—awaits a far more careful and detailed analysis of long-term effects on land quality and quantity, water quality and quantity, economic and cultural effects on farm communities, and side-effects (including CO_2).

I should like to offer the following generic comments:

The report often presents findings valid only in particular but unspecified circumstances, draws conclusions not justified by the data, or offers findings that may well be true but are not shown to be true by the data given. As is perhaps predictable for a committee effort done in a hurry, it appears to have been integrated with a stapler.

A critical omission is scale analysis. As DOE publications have pointed out, small- and medium-scale alcohol plants may have significant economic advantages (see e.g. Energy Consumer, Jan. 1980, pp. 12–13, and SERI's Fuel from Farms, p. 5). Net system (dis)economies of scale are a composite of many factors, including: specific capital cost, lead time, reliability, feedstock collection and transportation costs, product transportation and use patterns, suitability for mass

production and for use of simplified processes or recycled materials, suitability for integration with other processes or equipment, maintenancse costs and specialization, technical efficiency, buffer-storage and backup requirements, rate of technological change, uncertainties in demand forecasts, control of residuals, and several other effects (see my Annu. Rev. Energy 3:477–517 (1978) survey of scale effects at 483–9). The ERAB report reflects no such scale analysis, but rather doctrinaire assumptions about construction costs for a plant. This leads to reversals of logic, as at the bottom of p. 19 and the top of p. 21, where an assumed large plant leads to large feedstock shipping costs rather than optimizing plant scale to minimize total cost. (This may soon involve mobile plants—Energy Consumer, Jan. 1980, p. 15—such as are already available for pyrolysis.) The report includes qualitative language (p. 14) admitting that small plants can pay, but bases its analysis on a 50 million gal/y plant that may have substantially higher system costs.

The "food vs. fuel" arguments considered in the report seem to me to emphasize subjects in inverse ratio to their importance. Those of the greatest importance to the ability of the US and the world to feed itself in the long run—converting grains inefficiently to meat, mining soil, and mining water receive relatively little emphasis. The report's commendable emphasis on the problem of soil fertility does not go nearly far enough. Let me amplify somewhat my concerns about soil and water.

The United States is losing topsoil faster than it was in the Dust Bowl years when the Soil Conservation Service was established. A dumptruck-load of topsoil is passing New Orleans every second. Wind and water erosion is losing us an average of at least 9 tons/acre y, up to 25 in parts of the Midwestern breadbasket. (That doesn't even count the soil that is compacted burned out, or chemically sterilized.) Present chemical-based intensive agriculture, even without alcohol production, is a mining operation—mining the organic matter in the soil, mining what might be thought of as finely pulverized young coal. (The mean age of carbon in prairie soils is hundreds to thousands of years.) The same goes for conventional intensive forestry. Using marginal lands of higher slope with similar cultural practices would make the erosion much worse. Switching crops, e.g. from soybeans to corn (OAF report p. 9) would not make much of a dent in the problem: with present standard practice, each bushel of corn grown loses about two bushels of topsoil.

David Pimentel, principal author of the ERAB report, is to be commended for his longstanding concern with loss of soil fertility. He appreciates much better than some of today's farmers that soil, if it is to last, must be treated as a viotic community, not as so many acres of dirt. But even his critique of modern agriculture does not get to the root of the matter. I suspect increasingly that Wes Jackson (co-director of The Land Institute, Rt 3, Salina, KS 67401, (913) 823–8967) is right in suggesting that we are facing not only problems in agriculture, but the problem of agriculture: that in the long run, the plowshare is as destructive as the sword. To be sustainable, monoculture of annuals must give way to polyculture of perennials—potentially as productive a system, imitating the original climax communities such as the tallgrass prairie, but not requiring tillage or significant chemical controls.[2] The low- and no-till practices you saw on the Gordon farm in Stonington, IL (Energy Consumer, Jan. 1980, p. 7), cutting direct on-farm energy use in half, are clearly a good interim step. The integrated shelter-food-water systems developed at various scales by the New Alchemy Institute (Woods Hole, MA) are another pioneering step.

Present US agriculture is unsustainable in terms of water as well as soil. Consider, for example, the Oglala aquifer, stretching from North Texas to the Dakotas through west Kansas and eastern Colorado. Its Pleistocene groundwater is currently being mined for center-pivot irrigation (which, incidentally, is responsible for much of the growth in electric demand in that region). The aquifer, according to Dr. Jackson, is being drawn down 4–5 ft/y and recharged about ¼ *in*/y. Its water supplies about 23 percent of all US irrigated acreage and about 40 percent of all US feedlot cattle. The 14 million acre-feet drawn from the Oglala in 1979 exceeded the 1979 full flow of the Colorado River at Lee's Ferry (12 million acre-feet): if the Oglala aquifer were a river, it would be in the top 30 in flow-rate of *all* US rivers (the Delaware River, for comparison, is 33d with 12.5 million acre-feet/y). Dr. Jackson estimates that adding enough

[2] See Dr. Jackson's "New Roots for Agriculture," published this month by Friends of the Earth (124 Spear St., San Francisco, CA 94105).

weight on an Oglala-irrigated corn feedlot to produce a marginal pound of final-yield beef corresponds to a loss of 19–111 pounds of eroded soil and of over 8000 pounds of mined, unrecharged groundwater. Exhaustion of that groundwater would eliminate some 42 percent of all US agricultural exports.

I emphasize these land and water issues not only because they affect dramatically the amounts and prices of feedstocks available to make alcohol fuels, and the net energy yield of the alcohol fuel system, but also because without urgent and sustained attention to these issues there will not for long be American farming and forestry to sustain us or anyone else. Thus the most important requirement I think must be placed on an alcohol fuels program—one that does not really emerge strongly from the ERAB report—is that it be treated not as a way to put still more pressure on an overtaxed farming system, but rather as a vehicle for fundamental reforms in cultural practices that can make our farming and forestry sustainable. Thus I am not talking only about the narrow financial questions of discounting soil fertility and judging the value of cellulose residues (which nobody knows how to do), but about rethinking agriculture. This is in any case essential because most American farms are grossly overcapitalized. This year, when land values have stopped inflating and are even falling in nominal terms, the carrying charges can no longer be paid, and American agriculture is probably in its worst financial shape since the Depression. We are starting to see thousands of mini-Chryslers throughout the Midwest. I suspect those who may come best out of this crisis are the small farmers who have stayed closest to low-capital, soil-conserving techniques and whose traditional wisdom is proving greater than that of the sophisticated managers of corporate agribusiness.

The ERAB report hints that there may be modifications of present farming practice which both yield more cellulosic residues and protect the soil. In west Kansas I recently found what appears to be an example. Wheat farmers there were saving money on fertilizer by planting rotations or inter-row crops such as clover, alfalfa, and winter vetch, then plowing them under as a green manure. They then found that this so improved soil quality that they no longer needed to plow under the wheat straw for tilth: they could instead bale it on the combine (at almost zero marginal collection cost) and use it, if they wished, as an alcohol feedstock. We should be looking for more such examples and learning from them. Like Senator McGovern, I suspect that agricultural reform and fuel alcohol programs may be synergistic.

The report's treatment of available feedstocks is sketchy and inaccurate. As with energy conservation, what matters is not only the one or two biggest terms, but thousands of small terms. Each contribution, however important locally, may look nationally insignificant: there is apparently enough cotton-gin trash in Texas to run every vehicle in Texas, and enough distressed grain in Nebraska to do the same if the Nebraska vehicle fleet were very efficient, but these and a myraid others—walnut shells, rice hulls, etc.—add up to a lot only if one takes the trouble to enumerate them. ERAB did not do this. Accordingly, the total net EtOH production shown on p. 26 (Table 2) is about four times smaller than the net renewable liquids production shown by most authors (the canonical figure is in the vicinity of 6 q/y). Most of the difference—a 16-fold shortfall compared to the widely cited estimates of Poole and Williams (Bull. Atom. Scient., May 1976), for example—is in crop residues.

The feedstock source terms in Table 2 depend critically not only on which terms are counted—apparently all crop residues other than wheat and corn are omitted—but also on assumed recovery factors. The low net factors assumed (14 percent for corn and 11 percent for wheat) appear to reflect both tilth requirements and slope limits. No doubt this reflects conservative agronomic practice, but it does not take account of the considerable scope for simultaneously protecting soil and producing residues via agricultural reform (supra). The source term for forestry residues is even more sensitive to cultural practices. To be useful, Table 2 should have cited other widely accepted estimates—many 2–20 times larger—and discussed the reasons for the differences.

The principles for collecting cellulosic residues should include piggybacking on present harvesting operations, using existing equipment as far as possible, minimizing transportation costs (or, when necessary, bringing the plant to the wastes), and taking full advantage of existing point sources of wastes such as sawmills, cotton gins, some grain elevators, and food processing plants. Through no systematic assessment of the potential of this approach seems to have been done—perhaps the ERAB Biomass Committee will make a start—some well-

known assessments done at quite a fine-grained level (even by individual crop and county), e.g. by Alich & Inman of SRI, have already identified crop residues vastly larger than one would gather from this report.

Methanol, methanol-ethanol combinations, and mixtures including higher alcohols are treated very superficially. Inexplicably, ERAB considered methanol from coal (which the Panel was asked about) but not from woody materials (which it was not, but which surely deserves comparison). Wood has uniformly been found in practice to be superior to coal as a methanol feedstock: it has much more favorable reaction kinetics, pyrolyzes at much lower temperatures, tends not to crack to strong carcinogens, and needs simpler and cheaper conversion equipment. Extensive experience with wood-to-methanol conversion is available, e.g., from Prof. Olle Lindström of the Royal Swedish Institute of Technology (Stockholm). Prof. Sven Eketorp at the same institution is doing exciting work on coproduction of steel and methanol from woody feedstocks: thermodynamically, the MeOH is almost free, and the wood provides a superior steel quality because it is a sulfur-free reductant. I hope the Biomass Panel will also look—as the Gasohol Panel failed to do—at the work of Prof. Gustav Sirén (Svitiodsvägen 10, 18262 Djursholm, Sweden), the leading expert on sustainable and energetically efficient high-latitude forestry. He imitates natural successions to produce intensive but apparently stable polycultures, mainly Salix spp., and emphasizes the need, even while taking bole and tops, to leave twiggs and leaves that contain most nutrients.

While it was not formally within the Panel's terms of reference, I cannot resist re-emphasizing the importance of keeping alcohol production, or any other form of renewable energy supply, on the shallowly sloping lower portion of the supply curve. No kind of liquid fuel supply makes sense if we drive 15 mpg cars. In Foreign Affairs (Summer 1980) I calculated that rather than building synfuel plants of any kind, it would be far cheaper and faster to save oil by having the Treasury pay anywhere from half to all of the cost of giving people free 50 mpg cars, provided that they scrap their Brontomobiles and get them off the road. Alternatively, it would be cheaper and faster to save oil by giving people a cash grant approaching $200 for every mpg by which their new car improves on ther scrapped Petropig. While a properly done alcohol fuel program is cheaper than coal synfuels, it is far costlier than the kind of efficiency improvement we can gain—saving over 4 million bbl/d by 1990—by turning over the car stock faster. This should also make Detroit and the UAW feel much better about the recession. Without pushing present vehicle technology (see my FA references to Volkswagen and other recent work), we can run an expanded US transport sector nicely on about 6 q/y, not 17+. Even ERAB's 27 billion gal EtOH/y would suffice to run nearly the whole sector.

While the process by which the Gasohol Report was prepared was clearly defective, I do not mean by these comments to attack the authors' integrity. To the extent that the report says a massive grain-based ethanol program is undesirable, I concur. But to the extent that the report is used as ammunition against a diverse, fine-grained, dispersed, farm- and co-op-based, technically efficient, soil-protecting fuel alcohols program, it is badly framed and could deprive us of the only adequate and reliable source of liquid fuels for the long term and of the quickest source for the 1980s.

Sincerely,

AMORY B. LOVINS.

STATEMENT OF GREG J. MALONEY, THE ACORN FOUNDATION

Energy in Balance

Liquid fuel can be made from farm products through small scale biological fermentation into alcohols (SUN–FUEL), or from coal by chemical synthesis (SYN–FUEL). Oil companies own a lot of coal and want to dig it up, make it into fuel in their chemical refineries and sell it for use in cars. Farmers wish to make alcohol fuel and high protein concentrate feed to supply their own needs and to earn a livelihood from the sale of food and fuel.

To assess the two different ways of making liquid fuel; chemical, social, and health factors need to be taken into account. When a farmer makes alcohol by fermenting his crops, feeds the high protein mash to his animals, markets his livestock for food, and makes methane from the manure, he is in balanced harmony with nature and his community. The distribution of current, easily accessi-

ble information on regulations and methods of alcohol production to the farmer will assist him in making more alcohol for the country.

The production of liquid fuel from coal requires large factories, strip mining, and reclamation of the land, where possible. A recent report by the National Academy of Science and a study by the Office of Technological Assessment of Congress warn that the extended use of coal in any form would add cumulatively large amounts of carbon dioxide to the atmosphere. The carbon dioxide acts like a blanket, traps the heat of the sun, and raises the temperature of the air significantly. This warming effect is projected to have severe effects on the climate of the earth, including the melting of the polar ice and the flooding of coastal cities.

Liquid fuel production from coal uses a good deal of water. In regions where water is already scarce, the competition for it by the chemical factories could take water away from farm use and reduce the amount of food that can be grown; thus, producing a real fuel-for-food problem.

The coal fuel factories also produce large amounts of toxic chemicals; such as, organics, lead, arsenic, cadmium, fluorine, mercury, radioactive elements and other hazardous substances. Some are part of the manufacturing process, while others are contained in the coal itself. Release of these poisons into the air or water will damage the health of the environment and of the people who live in it. Factory generated chemical wastes must be taken care of if we are not to repeat more tragic cases like Love Canal where injury, disease, birth defects, property loss, and anguish were the legacy of carelessness.

Corn and other crops are non-toxic. They actually remove carbon dioxide from the air and add back the oxygen that we breathe. Alcohol fuel production from the farm is an exercise of good stewardship that provides local independent energy for the nation, food for the table, and money in the bank. The production of alcohol fuel from biomass can replace the dangerous lead and cancer causing additives now in our gasoline. It can help end our dependence on foreign oil in a decentralized balanced way.

STATEMENT OF DR. PAUL B. WEISZ

I was saddened to learn from Senator McGovern's press release that the Senator had been persuaded to include personal attacks on the integrity of two scientists, including myself, after our participation in a government study panel. It appears that the findings of the panel did not live up to the expectations of those who persuaded the Senator to take such personal action against us.

This is not the first time I have seen this type of persuasion in operation. During the early days of my scientific career, in pre-war Germany, "good" science was differentiated from "bad" science by whether or not its results happended to be desirable in the light of current political advocacy. And unwanted scientific results were attributed to bias on the part of individuals by virtue of their association.

Mr. Chairman, I wish to record the sad observation that there exist in this good country the symptoms of an analogous and dangerous tendency. Now, some problems of our society, basically of a technological and scientific nature, have reached public prominence and considerable urgency. One such urgency is created by the decline in availability of our vital energy sources. This has generated some vigorous advocates of ideas, theories, and philosophies. These advocates vie for recognition, financial support, or both. They can be innocent optimists and dreamers—or they can be opportunists driven by such motivations as profit, or personal recognition, or even the desire for socio-political change.

Some of these advocates are eloquent and persuasive enough to get their messages adopted and repeated by government officials, members of Congress, or others who cannot be familiar with the intricate technical background of each issue.

Promises of easy solutions to urgent problems tend to become popular, and they are therefore politically attractive. It is easy then to denounce a scientist who participated in a study which is perceived as falling short of promising the politically popular dream. And now we even experience the phenomenon of accusing individuals of bias by affiliation or association—in this case, with an oil company.

Mr. Chairman and gentlemen, you and all of us face a difficult task: How do we differentiate between persuasive advocacy of causes on one hand, and realistic scientific analysis on the other?

In the history of civilization, one important mechanism for this differentiation has been the advisory process which relies on the community of professionals with diverse and proven experience in rigorous analysis of physical and technical problems. These individuals have been brought up in the traditional discipline for securing an optimum of objectivity: open exposure of findings and analyses by publication in established journals of the technical and scientific community. This provides checks and balances, and has been the well-tested process by which soundness is constantly tested and objectivity safeguarded.

I am sure that the process, at any one time, can have its deficiencies. But I submit to you that, on a continuing basis—it is the best system humanity has yet devised.

The advocate of causes, in contrast, often does not allow himself such wide exposure for patient and full examination of his underlying assumptions—and often, thereby, a more critical view of his motivations. He will resort to privately circulated papers; he will introduce his concepts and schemes in testimony to influence policy makers; he will "leak" information, cause pronouncements to be written by columnists (e.g., Jack Anderson), or enter his offerings in the daily press or weeklies (e.g., The New Yorker); or he will publish in journals dedicated solely to his specific advocacy, and for use by the advocate.

Advisory panels and boards like the Energy Research Advisory Board are cross-sections of experts who, while diverse in knowledge and experience, have their roots in the broad community of disciplines to test concepts by professional publication and quantitative analysis in preference to words and eloquence. They represent the stabilizing bodies used by free societies to guard against the pursuit of convincing but faulty ideas or ideologies. Congress, in 1972, also created such an advisory council and panels in its Office of Technology Assessment.

I urge you to support the utilization of such panels and to protect them from threats and allegations to their chosen participants, for the protection of the American people, and the safeguarding of the nation and this free society.

Thank you for allowing me to present this statement.

STATEMENT OF GENE WENSTROM

Distinguished chairman, members of the committee, and friends, it is indeed a pleasure to be here to discuss the feasibility and need for small scale, farm produced alcohol fuels.

My name is Gene Wenstrom. I am a family farmer from Elbow Lake, Minn., and am the Farm Structure Project Director. The Farm Structure Project is a study of the future of family farms.

I wish to make known criticisms that I and the rural citizens of Minnesota have with a recent report by a gasohol study group of the Department of Energy.

There are many problems with the gasohol study group's findings. First of all, the chairman of the seven-member committee had been a paid consultant to Mobil Oil Company. Also, Dr. Paul Weiss of the oil company's research and development department was a member of the study group. Dr. Weiss has developed a process whereby methanol is produced from coal products. It is not surprising, considering the background of these two gentlemen, that the study group recommended that alcohol fuels be produced by large energy corporations and be based on methanol made from coal.

Another criticism is that there was no respected voice on the study group that favored farm produced alcohol fuels. The study group also met without public announcement or participation, and it violated a DOE rule by not having transcripts made of who said what.

It is disturbing to many of us that such a study group should receive the seal of approval of the Department of Energy. It is disturbing to many of us that our tax money financed such a project.

Farmers and rural citizens are also concerned with the many conflicting signals coming from the government on the subject of alcohol fuels. One group says "yes" to alcohol fuels, another says "no", and a third studies the difference between the two.

I think the findings of the gasohol study group are symbolic of the problem with many government studies, and that is they are controlled by special interest

groups and they often are not imaginative enough to recognize the ingenuity of the private sector.

I have seen many studies in the past that have doubted whether farmers could improve their yield per acre, or whether they could improve their efficiency. But the farmers proved the studies wrong although the "scientific" evidence was against them.

Now, I'd like to turn to the proven feasibility of small scale production of alcohol fuels. The reasons to support farm produced alcohol fuels are well known to us in rural America. The main factors are energy self-sufficiency for farms and better prices for farm products. Alcohol fuels are being produced and used competitively with gasoline today, and considering the inevitable increase in gas costs, alcohol fuels will be more economical tomorrow.

One of the ideas that needs to be further explored in the area of alcohol fuels is what I call "energy cooperatives." In each rural area several on-farm alcohol fuel plants could be constructed. They would serve as an "energy cooperative" to fulfill the future energy needs of the area. The technology for such plants is already in place throughout the country—and they work. Federal policies should encourage such "energy cooperatives." I think it would be necessary for the programs to be drafted in such a way that insures the benefits are reserved for small scale producers. Giant—and even mid-sized energy companies—don't need any more government aid. If we allow the same companies that now control oil to get their hands on alcohol fuels, we have taken a step backward, not forward.

The President has described the energy crisis as the "moral equivalent of war." The Congress has thought and argued and started the process of encouraging alternate forms of energy. But I still don't believe there has been a sharp enough focus on the one key question—and that is what our next liquid fuel will be.

The best anwser to our future energy needs is alcohol fuel. The use of alcohol fuel, as we all know, has been around a long time. Our earliest cars used alcohol fuel, as do our race cars today. Germany and Brazil today are incorporating alcohol fuels into their economies. Brazil is relying almost exclusively on agricultural sources, such as sugar cain and sugar beets, to produce the fuel. They are even exporting some of that alcohol fuel to this country, and, I might add it is competitive at the pump with unleaded gas.

Despite the efforts of the members of this committee and others in Congress, the United States has not made the commitment to alcohol fuels that is necessary.

We have failed to embrace alcohol fuels because of some deep-seated stereotypes. The first is a stereotype that bigger is better. This stereotype is reflected in the findings of the gasohol study group and its proposed reliance on the big oil companies.

Another stereotype is that those who hold university degrees are the only people knowledgable on a subject. Again, this is evident in the gasohol study group which is made up primarily of university professors and corporate executives.

I strongly believe that if Alan Zeithammer of Alexandria, Minn. or Floyd Hoff of Dalton, Minn., or a representative of the thousands who are producing alcohol fuels, had been on the gasohol study group, the findings would have surely been different.

I wish to challenge the gasohol study group, or any other skeptics of alcohol fuels to come out to Dalton, Minn. or Alexandria or any other small town or family farm. We don't claim to have all the answers about alcohol fuels, but we surely would expand the thinking and challenge the bias of a few skeptics.

Thank you very much, I'd be happy to answer any questions.

ETHYLENE CORP.,
Jacksonville, Fla., May 28, 1980.

Senator GEORGE M. MCGOVERN,
Dirksen Building,
Washington, D.C.

DEAR SENATOR MCGOVERN: In recent times, we have been constantly combatting a disturbing amount of propaganda in both State officials and newspapers based in large part upon several documents. Some of these documents are entitled "The Gasohol Study Group Report", by a group calling themselves "The Energy Research Advisory Board" and implying that they represent a Federal fact finding group.

Other reports by the EPA and Office of Technology Assessment also seem to fall in line with the above material.

What is disturbing to us, after reading this material is its totality of misinformation and/or lack of awareness about the real world aspects of fuel alcohol production. It would almost appear as if some vested interest were controlling the writing to purposely produce misleading information to deter this area of fuel development.

Ethylene Corporation has, at its own expense, conducted an intensive three year study on the total concept and feasibility of producing fuel alcohol and attendant by-products before embarking on a full scale program of its own.

The following was developed as a result of that study and is now being implemented in five plants presently under construction or development.

(*a*) A study of arable farm land in seven southern states to determine the amount of available farm land not now utilized in the growing of food crops, tree farming or permanent livestock pasture. The study revealed that there was some 54,000,000 such acres available, and discussion with several State governments suggests that they would be willing to make another 30 million acres available for appropriate cultivation along highway and freeway right-of-ways that must now already be mowed and maintained. Additionally, there were another 64 million acres engaged in marginal, non-food activities such as tobacco and cotton farming or part time pasture lands. Thus, 136 million acres could be said to be available for fuel alcohol feedstock farming over seven southern states.

(*b*) A study of starch yield per acre of crops with maximum dual yields indicated that certain hybrid strains of sweet potatoes, which mature in 80 days, and yield a high starch and protein crop, also yield a near perfect carbon to nitrogen balance in the vine for the conjunctive production of biogas yielding scrubbed methane gas, which would provide fuel for the ethanol plant's operation and a by-product of fertilizer for the crop fields.

(*c*) Engineering evaluations of existing ethanol distillery designs indicated an old and inefficient design approach, which we studied and re-engineered to produce a simpler and far more efficient design.

(*d*) Evaluations of existing conversion enzymes (alpha amylase and gluco amylase) and yeasts revealed some extraordinary advances in these areas which had not yet been adapted and utilized by the distillation industry, but which we adopted for our systems. Their use has reduced the energy requirements and costs of cooking, reduction and fermentation substantially.

(*e*) Evaluation and study in plant propagation and planting and harvesting methods led our agriculture technicians to the single cell culture of sweet potatoes under lab conditions to a point where the best of a hybrid strain can be ground up and placed in a hormone culture medium, where in six weeks, it will reproduce many millions of rooted plantlets. This culture medium containing these plantlets can then be placed in holding containers behind tractors and literally injected into the ground, ten rows at a time, almost eliminating the formerly grossly expensive cost of green house propagation and stoop labor planting.

(*f*) Our Agriculture technicians together with the Company's legal and financial management staff then designed a farmer participation plan, not unlike a Farm Energy Cooperative, which insured a long term steady supply at reasonable cost of the ethanol plant's feedstock while giving a larger and steady income to the farmer helping to stabilize economically depressed farm regions.

(*g*) The Company's engineering department is developing a practical, low cost dual fuel carburetion system which would probably cost less than a hundred dollars installed and permit a car to run on either pure fuel alcohol (180 to 190 proof) gasohol or gasoline by a throw of a switch on the dashboard. At present, the engineering department has perfected a simple $18.00 conversion system which will permit any vehicle to be converted to run on 180 to 190 proof fuel alcohol with the fuel cost below a dollar a gallon. The Company has, at present, a number of vehicles converted and running on 190 proof alcohol with no problems or adverse effects and no visible sign of any change.

What these results and our present pilot plant operation bear out is the following:

If just the farmable land now available in seven southern states alone were utilized fully to produce fuel alcohol it would:

(*a*) Not divert one acre of food crop land from food crop farming.

(b) Two crops a year would be able to produce enough sweet potatoes and sweet potato vines to produce:

1. 136 billion gallons of 190 proof fuel alcohol per year.
2. 340 million tons of protein for human and/or animal consumption.
3. 160 trillion cubic feet of methane (natural) gas.
4. 80 trillion cubic feet of carbon dioxide, (from both alcohol and biogas production).
5. 272 million tons of sludge fertilizer or feed supplement as a byproduct of anaerobic digestion of the sweet potato vine.

Furthermore, it would produce over 97 billion dollars in Farm Income and distillery worker and fuel alcohol production distribution worker income, principally in rural areas, and add over 544 billion dollars in gross national product.

We do not state these figures from studies alone, but from hard facts developed by the practical experience of designing, constructing and operating the production units we describe and working with the farmers in several states to develop our plan of operation, distribution and use.

We feel that these facts merit the same sort of distributions as those distributed by hte studies cited above which I doubt, were based on the same sort of hard data and practical experience as our company has had.

We cordially invite you to ask us questions and examine our data base to determine the truth. It is not based on the abstract and questionable data gathered by so-called "experts" but rather on facts and information developed in the actual doing and field study gathered by scientific "plumbers", "Hands-on" engineers, real farmers, hard working agricultural technicians and scientists and hardnosed MBA financial analysts.

Sincerely,

JOHN C. GARLAND,
Vice President.

Enclosure.

COMPANY PROGRESS UPDATE

Ethylene Corporation has accomplished a substantial amount of progress since January 1, 1980 in several key areas important to the overall development of the ethanol (fuel alcohol) production industry in Florida.

In March, its home office pilot plant went on line at Jacksonville where it is used primarily to test new evaporation distillation approaches which might reduce the time and capital equipment cost of the full scale plants under fabrication, and it also tests various new enzymes (for starch to sugar reduction) and new forms of yeast culture developed by private companies in the microbiology fields.

In April two plant sites were acquired in Jasper, (Hamilton County) and Starke, (Bradford County) Florida. Surveying and civil engineering were begun for construction of the foundations and plant site layout.

The first of five, three million gallon per year ethanol/methane production plants fabrication, was begun by Bethlehem Steel in Jacksonville, is scheduled for delivery in prefabricated state to the first site at Jasper on or about July 15th, 1980 with erection to be completed by August 15th, 1980.

That same month, Ethylene Corporation began working in cooperation with the State of Florida, Florida Junior College and the Duval County School system to develop three basic training programs that would support the long range plant installation projections for technical and skilled labor employee requirements.

Two outstanding educators were hired in developing training programs for distillery technicians, materials handling technicians, and to teach truck, car, and tractor carburetion conversion techniques which permit vehicles to be converted to run on 190 proof fuel alcohol.

These training programs are expected to be completed and ready to be implemented in early June so that the first group of graduates will be ready to undertake the first plant's operation in mid August or early September.

Presently, the Company is working to acquire other plant sites in Clay and St. Johns, Baker and Charlotte Counties.

To date the Company's agriculture division has signed up 45 farmers in the first two counties scheduled for plant installation this year to grow crops on contract in accordance with the plans outlined in our printed material.

These farmers will provide 100 percent of the feedstock necessary to support the plants at start-up with a start-up capacity for each plant of just under a million gallons per year.

It will yield an approximate income to the farmers in cash of around $400 per acre per year plus the value of 50 gallons of fuel alcohol per acre per year and 1,600 lbs. of retained livestock feed per acre per year. The livestock feed supplement is a result of the protein by-product produced in the fuel alcohol manufacturing process.

The value of this retained fuel and feed is about $375 per acre per year. Each plant, at start-up, is expected to produce $1,100,000 in wages and crop payments in each county and at full production that amount will have grown to $4,800,000 in each county.

Present corporate projections are to develop a total of 30 such plants by 1982 in 30 different counties of the State with some of the plants producing an excess of methane fuel beyond the plants' own needs in order to supply fuel needs for other industries located nearby which require natural gas for their operation.

Toward the end of April, Hampton McRae, Senior Agriculture Technician with Ethylene began an experiment through IFUS at the University of Florida to develop a single cell culture method to develop large quantities of hybrid strains of sweet potato seedlings in a manner that will reduce both the seedling propagation cost and the planting costs substantially.

The new method would grow seedlings in a culture in the laboratory (as opposed to in a greenhouse) in the millions of seedlings per tray set up. This reduces seedling growth time from 16 weeks to about 6 weeks. This allows a new planting technique which permits injecting the growth promoting hormone culture to be injected into the soil rows, ten rows at a time, from a set of hydraulic drills pulled behind a tractor instead of the backbreaking stoop labor encountered to now.

There are a number of other advances still on the drawing board including the development of a dual fuel carburetion system which may be mass produced and sold to the consumer for under $60 and which permits a car to burn either 180 proof fuel alcohol, gasohol or gasoline at a flip of a switch from the dash. This would permit an earlier development of a consumer market for fuel alcohol rather than limited motor pool vehicle market where refueling of fuel alcohol burning cars takes place at the motor pool only.

At this writing the St. Johns County Mosquito Control is in its second week of using 180 proof fuel alcohol for both the truck and the fogging machine.

A second motor pool vehicle test will begin as of May 20, 1980, with the Jacksonville Electric Authority with the fuel costing each agency 80 cents per gallon as manufactured by the company's pilot plant in Jacksonville, Florida.

A Step by Step Correction of the Report on Gasohol Originally Prepared for D.O.E. by the D.O.E. Energy Research Advisory Board [1]

I. INTRODUCTION

Gasohol is being sold now at over 2500 gas stations nationwide. The gasohol production was started by a group of citizens concerned with the decreasing supply of motor vehicle fuels that cause supply uncertanties and high prices for the energy requirements of the farmers at a time that agricultural surpluses were causing a price drop in U.S. farm products, economical difficulties for the farmers and U.S.D.A. policies compelled to recommend the decrease in U.S. agricultural production via heavily subsidized set aside and diversion programs. Gasohol was thus an attempt at integrating U.S. policy so that one sector, the agricultural sector, could become a help to another sector—that is the energy production sector. The short history of developing gasohol in the U.S. is marked with many instances of unjustifiable opposition from the detractors of such a development. Recently several additional reports have been released with what seems to be an intent to slow down the developing gasohol industry. One such report is the report on gasohol of the D.O.E. Energy Reseach Advisory Board (ERAB) and another is Worldwatch Institute's pamphlet No. 35, "Food or Fuel: New Competition for the World's Cropland".

In order to shed light on the subject of gasohol while pointing out where we believe that the originators of those two reports erred, the present short study follows the exact outline of the ERAB report so that, if needed, the reader can

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[1] The corrections were prepared for the use of S.E.R.I. and the D.O.E. and made by Pincas Jawetz, Independent Consultant on Energy Policy, New York, N.Y.

in effect compare the two studies section by section and see for himself why the present paper professes to have a much more favorable view on the subject than emerges from the two studies mentioned above.

Gasohol is defined as a mixture of 10 percent ethanol produced via fermentation process of biomass and 90 percent unleaded gasoline. The present paper proposes to redefine gasohol rather in terms of the octane boosting property of ethanol when used in high octane unleaded gasoline. As such the reply to the first question that comes to mind is:

(1) "What are the potential benefits of gasohol from both an energetic and from an economic perspective?", has to be directed not only to the economics of the production of ethanol but also to the petroleum crude replacement value of the ethanol when used—not as a mere extender to gasoline but rather as an octane boosting additive to high octane unleaded gasoline—replacing not merely gasoline but rather the octane value improving ingredient in the resulting marketable high octane unleaded gasoline.

The additional questions that have to be answered are:

(2) What is the potential impact of gasohol production on agriculture, land use, and the environment?

(3) In addition to grain and other starches and sugars, are there other biomass sources available for gasohol production?

(4) What are the comparative benefits of ethanol production from grain and methanol production from coal?

(5) Are tax incentives really needed for gasohol production? What policies caused distortions of the energy production industry and what are the available alternatives?

II. FINDINGS

A. Gasohol energetics and economics

(1) As a worst case analysis using existing technology with existing oil or gas-fueled fermentation/distillation plants, the net energy return for ethanol production from corn and other crops is positive, albeit small, but even for this limiting case, when one analyzes the alternatives to the use of ethanol as an octane booster for unleaded gasoline, and when performing a full energy balance analysis that includes not only the production of ethanol but also the uses of ethanol, one finds large savings in petroleum crude at the refinery.

If fermentation/distillery plant, using existing fermentation/distillery technologies, were fueled with coal, then each gallon of ethanol produced could save a minimum of 2.7 gallons of crude. One could under these conditions see the production of ethanol from biomass as a very efficient immediate way for the conversion of coal into liquid fuels. Furthermore, when improved technologies will become available, and one can foresee the possibility for such technologies, additional savings in fossil fuels, both oil and coal, can be achieved.

(2) In the 1980–1985 time period, total ethanol production using grains and non-oil/gas-fired distilleries could have significant effects on the world oil market.

Production of ethanol could reach in the U.S. 5 billion gas/yr by 1985. If utilized in producing gasohol, close to 100 percent of the national unleaded gasoline requirement in 1985, which is expected to be 50 percent of the total use of gasoline in the U.S. at that time, could be gasohol.

This would replace over 8 billion gallons of gasoline and an additional 8 billion gallons of crude thus having an end effect of decreasing the importation of oil to the U.S. by 310 million barrels. Assuming the size of imports of crude to this country is 50 percent of its needs in 1985, one could thus say that the use of gasohol would decrease the imports of crude by close to 25 percent of that size of imports without the gasohol program.

The world market price of crude is set indirectly by the gap between demand and supply. This small differential rather than absolute demand numbers bears the responsibility for the world's present economical difficulties.

Gasohol produced with existing technologies presents the most immediate available means to supply to our economy an alternate liquid fuel and it is in fact the only non-oil supply of liquid fuel by 1985. This will allow for the time needed to develop other methods to supply other liquid alternate fuels such as methanol from biomass. methanol from coal or oil from shale and tar sands.

If the production of fermentation ethanol from cellulosic materials is brought on stream an additional potential for the further production of over 27 billion gallons of ethanol/year exists. The immediate phasing in of gasohol can be viewed thus as a near term and medium term means that will allow the economy to adjust for long term solutions that may be of a different nature.

(3) The existing fermentation/distillery plants producing ethanol were built to produce alcohol used for the beverage industry. This very definite end-use, and the fact that the plants were built at a time that energy was of no concern, has allowed for the construction of plants fueled by oil and gas. No one is expecting to build future plants in a similar way and rejecting the idea of a gasohol oriented policy based on an analysis of existing distilleries proves nothing more than the personal resistance of certain factors to the idea that it is possible to have a fermentation-fuel-ethanol policy that makes sense indeed.

Nevertheless, even for the existing plants using oil and gas inputs, when one analyzes also the crude replacement value of the ethanol at the refinery when used as an octane value improving additive, one can show that these plants when used for the production of ethanol for gasohol can provide a substantial help for the nation by decreasing the reliance on crude.

(4) (a) The chairman of the American Petroleum Institute's Alcohol Task Force has stated at DOE hearings, Dec. 6, 1978, that it takes 6 percent more crude oil to produce unleaded gasoline than it takes to produce leaded gasoline. Or, in order to achieve an acceptable octane value, the additional reforming process, which is an energy intensive process, when replaced, could allow for large savings of crude at the refinery—6 percent according to A.P.I. and even higher estimates—as high as 20 percent—depending on the type of crude and the specific refinery, according to other sources.

About 3 percent ethanol when added to unleaded gasoline as produced at the refinery will increase the average octane value by one point (the average of the road and motor octane values). Gasohol—as defined by a 10 percent ethanol 90 percent gasoline mixture—will increase the octane value of a basic 87 octane gasoline by three additional octane numbers thus replacing the 6 percent of additional crude (at least). As this was achieved for the whole gallon of gasoline by 1/10 gallon of ethanol one can say that the effectiveness of the ethanol as a replacement for petroleum crude or for crude products is at least 160 percent.

(b) Additional gasohol benefits as stemming from a more efficient use of the energy content of the ethanol and an improvement of the mileage performance of gasohol are currently subjects of controversy as no universally accepted motor vehicle performance tests exist.

Nevertheless, if one were to accept that the gasohol performance is equal to the gasoline performance, this means that a fuel that contains only about ⅔ the BTU value of gasoline is just as effective as a motor vehicle fuel. The logical extension of this is that one can say that an additional increase in the effectiveness of the energy content of ethanol has been observed, equal to an additional 50 percent, for a total of 150 percent, and unrelated to the increased effectiveness that resulted from elimination of unneeded operations at the refinery.

(c) Based on the above-mentioned two observations, a factor equal to 2.4 (or 160/100 × 150/100) has been obtained. Each BTU of ethanol does therefore replace at least 2.4 BTUs of petroleum or petroleum product.

(d) Furthermore, when one looks now at miles/gallon results as experienced in motor vehicle fleet tests one has the indication that a probable increase in terms of miles/gallon is obtained when gasohol is used as compared to low octane unleaded gasoline. The Nebraska test results mention a 5.3 percent observed increase; Illinois tests mention 6.1 percent etc. If one were to take the average of these tests as an indication of the additional resulting saving in gasoline, an additional factor of 1.57 or an increased efficiency of 157 percent for the ethanol 1/10 of the gallon of gasohol results. The total effectiveness factor for the energy content of the ethanol as measured in BTUs will thus be 2.4 × 1.57=3.77.

(e) This discussion shows that the only controversy that one can still see in what concerns the energy effectiveness of the use of ethanol is the exact size of the factor showing the increased effectiveness in a motor vehicle engine of a BTU of ethanol as compared to a BTU of gasoline. The minimum value of this factor suggested here is 2.4 and further suggestions show that this factor could be as high as 3.9 or even higher.

(5) When producing ethanol from corn, the cost of corn constitutes about 63 percent of the manufacturing cost of ethanol. One is tempted therefore to say that major breakthroughs cannot be envisioned when attempting process research that is not related to the feedstock material.

This may be a shortsighted approach as one could improve the economics of the production of fuel ethanol by developing the co-products to the point that the fuel-alcohol becomes in effect a by-product in a food or feed industry. The economics of the overall process will allow therefore enough room for the search

of technology improvements in all the areas related to this industry. But, as said earlier, the phasing in of a gasohol-type fuel is not dependent on any future improvements—it can be done with present technology.

(6) The value of the by-product cattle feed (distillery dark grains) could reduce the impact of the high material cost (corn). In effect the nutrient value as animal feed of this material is considered superior to that of the corn. National U.S. policy could sway corn importing countries to buy D.D.G. instead of corn and thus decrease the cost of the corn to the distiller to nearly zero.

(7) Current tax incentives for ethanol production appear to be adequate to encourage the phasing in of a fermentation-fuel-ethanol industry. In effect, it may prove that one could have obtained all the funds needed to initiate this industry from the already existing regulation that allows the refinery to recoup the increased costs to produce high octane unleaded gasoline through the so-called tilt-rule. Also, subsidies that were used to keep land out of production through such programs as set aside and diversion programs of U.S.D.A. could have been used to help subsidize the production of ethanol instead.

(8) The production of ethanol from ethylene that was produced from oil in the U.S. does not make sense. Neither from the policy point of view nor from the economics point of view. Cheating that may have occurred in this regard is quite improbable. If this had been true Union Carbide, the world largest producer of synthetic ethanol, would not have been such an outspoken opponent of gasohol. Nevertheless, one should be prepared to find out such cheating and to prosecute the offenders. In what concerns imported ethanol, produced from biomass or otherwise, these are policy questions of another nature and we do not profess to touch upon this ground in the present paper.

(9) The production of methanol from biomass is being seriously investigated in Europe, Canada, and Brazil, and it is possible that a gasohol type methanol based high octane gasoline will be part of a European energy policy. Some of the advantages at the refinery mentioned would also apply to methanol though to a somewhat lesser degree.

The production of methanol, from biomass or from coal, is based on known technologies that have been developed by the Germans during World War II, and have been revived by South Africa with German help. The production of methanol from biomass is possible in relatively smaller plants but has not reached yet the stage of possible on-line production. On the other hand a coal liquefaction plant is a huge enterprise with long construction lead times and yet numerous unanswered environmental impact questions.

Research on methanol production from coal and the study of alternate uses of coal is needed to fully investigate this potential for the U.S.

(10) Research is needed on various agricultural systems will allow for the production of food while also providing primary material for the production of fuel-ethanol. All this while this while assuring that no harm is done to land productivity for generations to come and without damaging the environment.

(11) Cellulosic biomass is more abundant and the use of cellulosic wastes and possible energy plantations could make these primary materials the main biomass sources for the production of ethanol towards the end of the century. While ethanol from grain production is already a commercial enterprise today, because of research and development needs, ethanol from cellulose fermentation is likely to be commercialized only by 1985.

B. Gasohol impact on food and the environment

(1) The advantage of fermentation fuel ethanol (ffe) produced from grains and other agricultural crops is that it can provide a quick supply of liquid fuel starting in the early 1980's. In effect this is the only non-petroleum based liquid fuel that can be produced and used immediately, with existing technology, as part of the existing economical structure, and as fuel for existing motor vehicles.

Supplies of grain for ethanol production exist and are frozen in storage as a result of the Russian grain embargo and therefore present also a great political opportunity. Further grain for the production of ethanol will be available thanks to the great potential for the production of such crops in the U.S. In effect we are accustomed to take land out of production via such programs as the set-aside and diversion programs and to pay the farmers direct subsidies and indirect subsidies in order to give them the incentive to decrease producing land. Just two years ago we had 18.7 million acres in such programs and the grain that could have been grown on that land could have become distillery feedstock to produce about 4.8 billion gallons of ethanol.

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(2) One can easily demonstrate that the U.S. will have larger surpluses of grain for the rest of this century. As most of the grain for export is corn for animal feed, the taking out of the carbohydrate component of the corn and the exportation of the DDG will have no foreseeable large impact on foreign grain customers as well.

(3) Gasohol production should not be allowed to cause environmental degradation. One can trust the U.S. farmers that proper care will be taken that only such proceedings as deemed land conserving will be employed.

(4) Ethanol can be produced on individual farms in small-scale operations and the wet stillage can be fed economically to the livestock. Also, crop residues and other solid fuels available on the farm could be used as distillation fuels and these small-scale units could offer a degree of farm and rural community energy self sufficiency.

Furthermore, one could envision a milk industry type of collection system where the excess on-farm produced ethanol would be collected and transported to upgrading facilities that would turn over this ethanol for local blending with unleaded gasoline as an octane value improving additive.

(5) The supply of grain available for gasohol and livestock production may vary from year to year due to climate uncertainties in the U.S. and overseas. This may have an impact on ethanol production but then, knowing the needs created by the new industry, land that may have been kept out of production via U.S.D.A. programs will have been planted, thus decreasing the impact of such unexpected pressures on the grain market.

Furthermore, one has to realize that the suggestion of using grain to produce fuel is not caused by the desire to create a fuel vs. food competition, but rather by the observation that there is an excessive potential for the production of grain in the U.S. and one can take advantage of this excessive potential for agricultural production in order to help solve the needs created by a lagging energy industry.

(6) One can foresee that an unchecked world-wide population increase will bring about pressures on the world food market, but then one could also observe that in today's world-wide food and energy markets there is a vast disparity in use of food and energy between those that geography as well as industry have favored and those that because of the lack of resources, both tangible and in the form of skills, have had a slower economical development. The above mentioned truth cannot be used to halt the development of needed resource in an energy impoverished U.S. that, because of its dependence on uncertain sources of foreign energy, has been brought to a situation of eminent economic danger to itself.

Also, as the Indian experience has shown, countries that were used to get agricultural U.S. surplus or foreign aid remained dependent on this aid as long as it was available. The removal of this aid to India for several years was the catalyst that stimulated more than anything else local agricultural development.

C. Forestry and agricultural residues for gasohol production

(1) Forestry residues and waste products are a major resource with potential to produce by fermentation routes at least 27 billion gallons of ethanol per year. Utilization of some of these materials will obviously open up new accusations of competition with other commercial forest-based industries.

(2) Technology for energetically and economically efficient use of cellulosic biomass to produce ethanol by fermentation is being developed and could be available for commercialization by 1985.

(3) The cost of ethanol from cellulosic biomass is expected to be lower than from grain and sugar crops.

(4) There is inadequate quantitative information on the amounts of energy, especially oil and gas inputs, needed to maintain a sustained yield of agricultural and forestry biomass for energy production. An investigation is needed of the total inputs including: site preparation, fertilizers, pesticides, machinery, fuel, and any other inputs for sustained agricultural and forestry biomass production systems.

D. Methanol production from coal

According to oil industry sources, the capital cost for one 500 million gallon/year methanol from coal production plant is approximately the same as for twelve 50 million gallon/year ethanol fermentation fuel plants that will produce 600 million gallons/year of ethanol.

The increased total production capacity of the 12 suggested ethanol plants plus the fact that these plants will be dispersed geographically close to the source

of agricultural primary material, creating as well a more dispersed potential for employment, has a higher priority value in terms of a national policy.

Furthermore, the coal liquefaction plants must be large in order to take advantage of economies of scale whereas the fermentation/distillation facilities can vary in size, as their size is a function of a much more complex system that can take advantage of such complications as the collection system of the primary material biomass residues on farms, nearness to farms that could use the co-product animal feed without drying, nearness to a refinery that could use the alcohol as an octane improving additive, etc.

(2) Ethanol as part of gasohol does not present any problems to the present motor vehicle engine when used as an octane value improving additive. Methanol may cause some minor problems in the engine.

(3) The cost of production of methanol from coal is not known yet exactly as no plants have yet been built in the U.S. Proposals have been made that suggest that it is possible to produce methanol from coal at a cost much lower than that of ethanol from grain. These proposals are based on large-scale conversion plants that will take a long time to build and do not include costs of the capital, unpredictable but foreseeable cost overruns, and infrastructure costs (railroads, community construction expense, social and environmental costs, etc.)

(4) Methanol production technology from coal is currently available outside the United States and methanol production technology from natural gas is available commercially in the U.S. The initiation of commercial coal processing plants to allow "learning curve" improvements and research and development in the coal gasification step will allow for a possible development of this resource with commercial production of methanol by the turn of this century.

Similarly methanol from natural gas produced in remote places, such as Alaska, may become sometime in the future a welcome addition to supplies of energy, as well as methanol produced from bio-gas.

(5) If it were so that methanol can be produced at about one half to one third of the cost of ethanol production from grain, it is hard to see why the proponents still need "adequate guarantees for product revenue". Though not denying the future potential for methanol from coal, it is quite clear that this technology is further down the road than ffe.

(6) Production of methanol from coal carries with it potential environmental problems of great concern: land damage, air and water pollution and increased concentration of CO_2 in the atmosphere. The last problem is something as yet completely unclear.

III. RECOMMENDATIONS

(1) Incentives for investment in ethanol production should be tailored so that they will allow for the phasing in of this resource independent of the oil industries. This in view of the fact that corporations such as Mobil Oil or Arco have strong interests causing them to oppose the introduction of ffe. The oil industry should then be directed to use ethanol as an octane improving additive and be asked to phase out energy intensive refining processes that increase U.S. dependence on imported crude.

Assurance should be requested from newly constructed ffe producing facilities that these facilities are not fueled by oil or gas. Tax incentives should be tied to this condition and similar conditions should be imposed upon oil refiners intent to market high octane unleaded gasoline in the general sense of what was said earlier.

(2) Ethanol production as a near- and mid-term 1980's contribution to the liquid fuels supply should be allowed to find its own level based on current incentives and on the potential for financing that could be made available via the "tilt-rule".

There is a high probability of reaching several billion gallons of ethanol per year by 1985. Production of 5 billion gallons of ethanol per year later on could provide sufficient ethanol for 100 percent of U.S. unleaded gasoline as gasohol. The 1985 ethanol production could displace an equivalent of 900,000 bbls of oil per day or over 12 percent of U.S. gasoline consumption. Assuming that at the time 50 percent of the use of crude will be coming otherwise from imports, this will lead to a 25 percent reduction of the imports of crude for the U.S. or indeed a feat with serious consequences on the world economy as a whole.

(3) Tax incentives should be monitored carefully to insure that alcohol production from grains and other food supplies allow for the unobstructed avail-

ability of feed supplies for meat, milk and egg production and will not lead to further inflation in foods. If changes are needed in the subsidy system, as said above, funds can be found under the "tilt rule" regulation. If, then, after some time, it is found that additional distillery capacity construction is endangering the economy at large, the administration could stop using incentives for the construction of such facilities making the policy amendments needed to safeguard the supply of feedstock to the facilities that have been established by that time.

(4) Incentives in the form of a guaranteed supply of unleaded gasoline to be mixed with the ethanol is needed. This guarantee should apply for the investment lifetime that is even after Oct. 1, 1981 when gasoline is slated to be freed from controls. This incentive would insure capital investment in new alcohol plants.

(5) With the advant of ethanol from cellulose processes in the later 1980s one could see eventually new feedstocks for the ethanol distilleries that will be in production by that time. As such, one could look upon the facilities established relatively small front end changes, will be turned into ffe-from-cellulose production facilities. Considering the expected long-life time of the plants they deserve all the policy support that one can afford to give them.

(6) National land use policies are needed to provide environmental guidelines to prevent land productivity decline and environmental degradation associated with an expanded effort to grow grains and other crops for gasohol production.

(7) Assessments of fuel replacement equivalents of ethanol have been made showing that there is an effectiveness in the use of ffe much larger than one would calculate from its BTU value alone (see Findings section No. 4).

(8) Progress toward implementation of other technologies (methanol from coal, other syn-fuels etc.) must be monitored carefully with the expectation that their relative merits and timetables will be more clearly discernable by the mid 1980s. By that time the ffe will be in full production and will have opened the way for a nonpetroleum alternate fuels industry. Additional novel alternate fuels will find it thus easier to be phased in and one could also expect large contributions from ethanol from cellulose biomass as a substitute.

(9) Markets should be monitored to insure that ethanol from ethylene produced from petroleum in the U.S. is not used to replace fermentation ethanol used for gasohol. One can foresee that such a development is not only contrary to a normal energy policy but will also not make any economical sense even under a subsidized ffe production system. In effect one can easily foresee the opposite to be true—ffe will eventually become the basis for a new agrochemical industry similar to the existing petrochemical industry. Ffe and ethylene produced from ffe in a reversal of the presently commonly accepted chemical reaction will be the basis for the new agrochemical industry.

(10) Significantly increased support for research and development of cellulosic biomass production and processing technology is needed should an extensive production effort be called for in the future. This suggestion has the full backing of the chemical industry that is getting worried about future difficulties for obtaining supplies for chemical feedstocks.

Research is needed on problems of land and water resources and energy input requested to support sustainable agricultural and forestry biomass production systems. Of particular interest is the study for possible decrease in oil and gas inputs in such areas as fertilizer, pesticides, agricultural machinery and transportation, etc.

(11) One should encourage the oil industry to invest in investigating the possibility for the industry to produce methanol from biomass as well as other processes for coal liquefaction. In no way should one accept the undocumented conclusion as presented under recommendation No. 11 by the amazing one-sided oil industry favoring, DOE established, Energy Research Advisory Board—Gasohol Study Group which calls for an outright encouragement of the alcohol production from coal.

(12) Research is suggested in the areas of direct production of methanol from coal—that is the production of methanol from coal without an intermediary coal gasification step.

(13) The U.S. program for gasohol production should consider closely the impact of U.S. gasohol programs on the world food supply as well as the world energy supply. The U.S. by decreasing its requirements from the world energy supply will release indirectly the economical pressures on the developing nations that spend now in some cases over half of their GNP on imported oil. Also, the

technology that the U.S. is developing for the use of non-petroleum, non-gas, non-nuclear, sources of energy should be made available to these countries to enable them to help themselves, and by doing so to decrease further the world dependence on petroleum.

In many cases the food problem is interrelated to the energy problem and developing countries should be able to devise their own food production capability to nourish an optimum population size according to given geographical and development conditions.

Gasohol in the U.S., as planned now, is based on corn feedstocks, that leaves DDG that can still be used as animal feed. As corn is the historical main agricultural export commodity of the U.S., one could say that supplanting exports of DDG for the previous exports of corn is not going to have a serious impact on U.S. agricultural foreign customers.

(14) The environmental issues arising from ethanol production from coal should be examined in more depth. The possible benefits of lower production costs of methanol from coal should be balanced against the perceived risks. The additional expense needed to eliminate environmental risks and to build additional infrastructure should be taken into consideration.

The final analysis should take into account these last values and balance them against the same analysis for a comparable in size, but dispersed geographically, level of ethanol production in order to determine the priorities for the two principal alcohol technologies. Also, while doing this analysis, one should see how methanol from biomass compares with methanol from coal, and how a possible conversion of ethanol from grain distilleries to ethanol from cellulosic production facilities can influence future economics.

IV. AN ASSESSMENT OF GASOHOL PRODUCTION

A. Energy balance

At the start of an attempt at an analysis of new useful energy production via a fermentation fuel ethanol (ffe) program one has to make sure that it is understood that the final goal of such an ethanol production program is not the production of ethanol but rather the displacement of petroleum crude, and the bottom line of this analysis is that the production of ffe will make sense only if it decreases the dependence of our economy on imported crude.

When performing an energy balance of the production of fermentation fuel ethanol one has to start with oil and gas inputs in the production of fertilizers insecticides etc., needed in the agricultural process, to include energy inputs at the distillery facility, and to weigh these inputs against the crude that has been replaced when the resulting ethanol is put in use. What is being said here is that the analysis cannot be allowed to stop at the stage of the production of the ffe but has to include also the use of the ffe produced.

Most energy balance analyses do not include the use of the ethanol but confine themselves only to the production of the ethanol reaching incomplete, and therefore misleading, results. The material that will be put forward in this section has been presented on many occasions during the 1977–1980 period at D.O.E. hearings, in U.S. Congressional Publications, in other publications, and even twice before the Petroleum Division of the American Chemical Society (Jawetz).

When analyzing the gasohol program one is made aware that the ethanol when mixed with gasoline is rather an octane value improving additive and not a mere extender to the supply of gasoline. As such one has to compare ethanol not with gasoline but rather with the alternative octane value improving methods used by the oil industry.

As long as the oil industry was allowed to use lead compounds as octane improving additives this was a very satisfactory method to improve upon the low octane value of the gasoline when produced at the refinery. The present, Congressionally mandated, phase-out of lead compounds, is causing the refiners to look for one of several ways out. One way out would be to increase octane values via reforming processes and another way would be to use octane boosting additives. Reforming processes are energy intensive processes requiring additional crude at the refinery while non-ffe octane value improving additives are based completely, or at least to a large degree, on crude or natural gas. This additional fossil energy input has caused higher costs to the refiners for which they have requested and obtained the tilt rule to allow them to recoup those costs. What is worse, this additional need of crude has indeed increased our dependence on imported crude. To quote an industry source (Tosco Corp.): "Autos are using

almost the same amount of crude as ever, although there is a bit less gasoline used per mile. This is because the gasoline now being used is a higher specification gasoline, of higher octane rating, that yields better mileage but requires more crude or raw material * * * the auto industry has been increasing the efficiency of automobiles in part through higher compression ratio engines. Thus the problem (achieving more miles per gallon) conveniently passed from Detroit to Houston."

The additional input of crude needed to produce the high octane unleaded gasoline has been quantified for us by Jack Freeman, Chairman, American Petroleum Institute Alcohol Fuels Policy Task Force, when testifying at hearings held on December 6, 1978 before the D.O.E. Alcohol Policy Review Task Force. He said that an additional 6 percent of crude are consumed. According to Urvan R. Sternfels, Chief attorney for the National Refiners Association, this value was put at 5 percent while coonsultants for refinery construction, unofficially say that depending on the type of crude and the particular refinery this value can be as high as 20 percent.

Considering that the addition of about three percent ethanol to low octane gasoline increases the octane value (the average over motor and research octane) by one number, the addition of 10 percent ethanol will be enough to turn an 87 average octane value fuel into a 90 average octane value fuel, this will replace not only 10 percent gasoline, but an additional minimum 6 percent crude. One can thus say that the effective use of ethanol as an octane value improving additive increases the energy use to at least 160 percent of its nominal energy content.

Furthermore, the use of a higher octane motor vehicle fuel achieves also a better performance of the fuel as measured in miles per gallon, and the performance of a fuel in a motor vehicle engine is thus only a secondary function of its energy content as measured in Btu. In effect Btu is altogether the wrong unit to measure the use of a fuel in a motor vehicle engine as the Btu value measures only the potential for a transformation of chemical energy into thermal energy and not into a mechanical energy, as experienced by a motor vehicle engine. Considering that ethanol does have only about ⅔ the value in Btus as gasoline, and when assuming that gasohol achieves the same efficiency as measured in miles per gallon, one sees that the energy content of the ethanol, when used as an octane value improving additive to unleaded gasoline, is 150 precent of its normal energy value as measured in Btus. Multiplying this value by the previously obtained efficiency estimate that resulted from savings of crude at the refinery, one obtains a factor 2.4—a multiplier for the motor vehicle efficiency of ethanol as used in gasohol.

A third energy efficiency increase for ethanol is obtained when one does in effect measure the performance of gasohol in an actual motor vehicle fleet test. The available numbers from such tests are: an increase of 5.3 percent in miles/gallon as observed by Professor Scheller in the Nebraska test, and an increase of 6.1 percent in miles/gallon as observed by Al Mavis in the Illinois test.

Taking the average of the Nebraska and Illinois tests one observes a third efficiency equal to 157 percent of the energy content which included in the previous calculations increases the efficiency factor for the use of one Btu of ethanol in gasohol to 3.77 with a value as high as 3.9 for the Illinois case. What all this means is that in effect each Btu of ethanol when used replaces at least 3 Btus of petroleum or petroleum product—this even if one allows for some questions about the actual size of the gain in miles/gallon obtained in the motor vehicle performance of gasohol.

Having established the factor 3 for the use of ethanol we can now return to energy balances relating solely to the production of the ethanol. The total efficiency of a ffe program will be measured by multiplying the factor obtained in calculating the energy balance in the production of the ethanol by 3.

In order to obtain the maximum displacement of crude one has to plan the production of ethanol with a minimum input from oil or natural gas. Though, as we shall see, as a limiting case in a worst case analysis, even if one assumes the values proposed in Mobil Oil literature (Penick) that each Btu of ethanol produced consumes two Btu's of energy input (assuming all of this input to be from oil and gas) one gets $0.5 \times 3 = 1.5$ or an overall net production of useful energy.

Considering the ERAB report (Table 1 of the ERAB report) for the case that coal is used to fuel the distillery while oil and gas are used as inputs only for the agricultural inputs—input of 45,000 Btu results in an output of 90,000 Btu

in the form of ethanol or an efficiency factor equal to 2. When one multiplies this factor by the factor 3 developed for the use of the ethanol in gasohol, one gets thus 6.

The complete analysis of the ffe displacement of crude capability, according to the proposed corrections to the ERAB report, show that each Btu of input of oil or gas for the production of ethanol in the ERAB report results in six Btus of useful energy being produced. (This value is in good agreement with the factor 6.6 as shown by Pincas Jawetz using data presented by Professor Malvin Calvin that amounted to an ethanol output to energy input ratio 1.76 and using the ethanol use factor as 3.77.).

According to the ERAB table, out of 90,000 BTU produced 76,000 are as ethanol, thus the liquid fuel production energy-balance factor is equal to 1.69 which when multiplied by 3 equals to 5.1, resulting in a direct gain of an additional minimum of four Btu's of crude displacement value for each Btu of oil or gas that has been used in order to produce the ethanol—this without counting even the animal feed by-product that has resulted in the process.

Allowing for the smaller value in Btu's of ethanol, the 4 Btu's gained translate to a 2.7 gasoline volumetric factor.

A U.S. 5 billion gallon/year ethanol production program could, according to this calculation, decrease the need for crude, or crude products, by an equivalent of over 13 billion gallons, or by over 12 percent. Assuming a 50 percent expected import rate, one could see that this alone could lead to a decrease in imports of crude to this country by close to 25 percent of the imports, with tremendous implications for the world energy market.

B. Cost of grain alcohol fuel produced at the distillery

The corn raw material dominates the production costs, though much less than it was professed in the ERAB report.

The ERAB report (ERAB report Figure No. 1) shows an ethanol production cost of $1.39/gal but does not substract the co-product value of the animal feed that was mentioned by the ERAB report as 52¢/lb. When this is taken in calculation and substracted from the cost of the corn one decreases the 72.5 percent estimate for the agricultural feedstock component of the ffe production to 63 percent.

The selling price of the ethanol is going to be dependent on its use as a replacement for crude. In the calculations produced by proponents to build such plants the main considerations relate to debt financing, to the price of the corn feedstock, and to the income from the co-products. Perhaps not enough consideration was given to possible technological improvements, but then the difficulties encountered by the proponents, because of a wanton opposition from the detractors, have created difficulties in the normal development of ffe.

When allowing the "tilt rule" in order to make up to the oil industry for the increased costs related to the increased use for crude in the making of high octane unleaded gasoline, D.O.E. has in effect made available the funds that could have been used by the oil industry in order to phase-in gasohol (Jawetz). Albeit, the possibility of using these funds in the way suggested here was not explored by the responsible industry factors.

Process costs are sensitive to plant size and in effect the plant size will be determined by transportation factors such as the gathering and supply of the feedstock on the one hand, and the location of the refinery and the fuel market on the other hand. In addition small plants are profitable in farm and small community environments and a definite factor of diseconomy of scale favors such plants in these locations. (Fuel from Farms).

C. Cost of net fuel produced

As shown in section IV–A, favorable economics can be expected for the phasing-in of gasohol. Though taking a position that the value of $2.14 for "the real cost to produce 1 net gallon of new fuel energy as alcohol" given in the ERAB report is too high, as the ERAB study has neither given enough credit for the co-products or allowed for the full extent of gas and oil energy possible savings in the making of the ethanol, the present report will nevertheless use this value and analyze its meaning in the light of what was said in section IV–A.

The ERAB report states: "If future automotives fleet tests demonstrate that the gasohol blend is mechanically equal to gasoline, then the real cost will be slightly less than $2.14". Viewing closely this statement and remembering the factor 1.5 rooted in the observation that ethanol has only ⅔ the value in Btu's

when compared to gasoline, one sees immediately that starting with $2.14/gallon the cost drops to $1.43 a gallon. This is only step one in this present analysis.

Step two: given the factor 1.6 based on the increased property of ethanol to back out additional quantities of crude at the refinery, when the ethanol is used as an octane value improving additive, the "real cost" of a gallon of ethanol drops further to $0.89 a gallon.

Step three: taking in consideration that additional increased efficiency of gasohol, as measured in miles/gallon, can be attributed to the ethanol octane booster, and using the factor 1.57 as described in section IV–A, one sees that the "real cost" of a gallon of ethanol drops further to $0.57 a gallon.

One can calculate thus that the values presented in the ERAB report when understood correctly show a "real cost" of a gallon of ethanol to be less than 60 cents and thus fully competitive today with the cost of gasoline, provided that the oil industry would use the funds made available to it via the tilt rule to expand distillery capacity instead of building new reforming capacity. As long as the oil industry will not agree to the route presented here, one will have to rely on the federal and state tax incentive system (DOE, 1979) to make alcohol competitive with gasoline.

D. Ethanol from ethylene

There is no sense in using petroleum based ethylene to make ethanol for blending with gasoline as this is not going to increase the available non-petroleum based supply of liquid fuels. In effect one can foresee that like in Brazil and in India, eventually also in the U.S., ffe will become the source for ethylene in a reversal of the reaction presently used to produce industrial ethanol.

If CMR has observed that possibly more ethanol is sold as part of gasohol than one can account for when tabulating the existing production capacity for ffe in the U.S. then the answer is to be found rather in the import of fermentation ethanol produced from sugar cane in Latin America. Such imports should not be discouraged though, as they help us not only directly by supplying a liquid fuel to the U.S., but also indirectly by decreasing the demand for crude worldwide. Also, the ethanol exporting countries are in need of aid from the U.S. and opening this new avenue for agricultural exports for those countries strengthens their economical situation and may decrease the danger for internal unrest.

V. IMPACT OF GASOHOL PRODUCTION ON FOOD AND THE ENVIRONMENT

A. Competition for the grain resource

The argument as it goes (Pimentel, et al. 1980, Brown) is that the use of grain to produce gasohol will influence the quantities of grains that are available for use in U.S. livestock production as well as the amount available for export. As an example to support this argument, opponents of a U.S. gasohol program based on agricultural products always bring out the situation that occurred in 1973–74 when world demand for grains increased and U.S. exports of grain increased, causing price for grains used in the local U.S. market to more than double (corn from $1.15/bu to $3.05/bu). Because it was unprofitable to raise livestock with this price of grain, farmers sent large numbers of animals to market and the amount of grain livestock declined by about 30 percent. This in turn caused the following year higher prices of meat, milk and eggs.

What this example does not tell us is that the sudden rise in export could have been avoided had there been a better agricultural exports policy at the time.

The exports of grain went to developed and not to developing countries. Corn was exported at low prices to the Soviet Union, so that they could feed their livestock, in a move that left U.S.D.A. amazed at what went on without their knowledge. An analysis of U.S. grain exports shows over 85 percent of the 2.4 billion bushels of corn the U.S. exported in 1979 went to developed nations. As pointed out by Senator Birch Bayh wheat and rice are the crops used to help feed the developing nations and not corn. In 1979, 637 million bushels of wheat and rice vs. only 273 million bushels of corn was exported to the Third World countries.

The co-products of corn ethanol production are very important in a food and feed supply analysis. The exact co-products that are produced depend upon the process used (Keim). In the classical distilery method, the entire kernel is hammer-milled to a powder which then is cooked, fermented and distilled, leaving as a residue all of the non-carbohydrate material in the corn. This is dried and sold as a feed material (distiller's dried grains and solubles—DDGS). In effect as DDGS contains all the protein in the corn in a concentrated form (27–29 percent

of the DDGS is protein) this material is recognized as a more valuable feed than the corn itself and is sold at prices little above the price of corn. According to the efficiency of the process, the amount of DDGS is about 17 lbs per bushel of corn.

When wet-milling is used for the pre-processing of the corn, several co-products are recovered in higher degrees of purity including corn germ or corn oil and also corn gluten meal or corn gluten feed which command large premiums in their price as they are superior co-products.

What has been said here is that the marketplace has recognized a long time ago that there is no loss of the valuable nutrient qualities of corn when the hydrocarbon part of the corn is extracted in the production of ethanol. This leads to the thought that if one could produce additional quantities of hydrocarbons by growing other crops, more rich in hydrocarbons, one could thus replace the hydrocarbon part used now as feed based only on corn while the more important protein part of the feed will continue to come from corn. New agricultural systems may be needed including different crop rotation and such systems have been proposed by scientists like Professor Barry Commoner who suggested that the corn-sugar beet-hay rotation when replacing the existing corn-soybean-hay rotation would produce more additional hydrocarbon than an effective fermentation-fuel-ethanol based on corn alone would require.

Furthermore, the question of competition for grain between food and fuel industries, through foreseeable, is not an immediate danger. The simple factors are that the U.S.A. is not short of agricultural land at the present time. In effect, we have a higher potential for growing food than we would like to have as becomes clear when the agricultural policies of U.S.D.A. are reviewed. Our official policy has always been that in order to support the price of grain we keep land out of production via direct and indirect subsidies to the farmer.

These so-called set-aside and diversion programs as recently as 1977–78 have kept out of production good, certified, agricultural 18.7 million acres. Had we planted this land with corn one could have obtained 4.8 billion gallons of ethanol (Jawetz) and a quantity of DDGS that would have flooded the soy bean market. The danger thus was not in the non-availability of feedstock to the distillery but rather in the excess of feed that would then have depressed other markets. This last fact was more of a worry to U.S.D.A. planners than any forseeable shortage in feed or food to developing countries as Dr. Lester Brown would like us to think. At the present time, as Business Week, May 19, 1980 points out, the government may be ending up owning so much grain from the cancelled Soviet contracts that we would in effect not know what to do with this grain "Because the contracts U.S.D.A. signed initially specified deliveries throughout February and March, officials had to scramble to renegotiate later dates to avoid taking physical possession of the grain. In the process however, they were compelled to pay export companies nearly $150 million for the costs of storing the grain and helping prices in the futures markets."

To summarize this section, though an eventual limit for agricultural production can obviously not be denied one can with certainty say that the production of corn-ethanol is not going to impact existing supply of food or fuel and future changes in agricultural policy could guarantee the availability of feedstock to the distillery to the end of this century and beyond.

B. Land use and the question of land degradation

It is quite obvious that the amount of land available to agriculture is limited but nevertheless, the use of this land is a function of U.S.D.A. policies. Set-aside and diversion programs in U.S. farm policy are historically a cyclical event. Putting more land into these programs should theoretically decrease the supply of grain and thus support the market price of the produce. Instead, farmers learned to take advantage of the U.S.D.A. program benefits while increasing production of grain in the planted land by increasing fertilizer application and farming intensity. Following average yields per acre values one sees that the U.S.D.A. programs never had the full impact hoped for when these programs were formulated.

The real question today is the increase in the cost of energy and how this will change farming procedures. Studies are needed today on ways to decrease fertilizer use and to develop less energy intensive farming practices. On the other hand, changes in the agriculture should allow for the developing of new species specifically used in energy crops providing fermentation feedstock for fuel ethanol production.

Furthermore one should avoid monuculture practices now that no depletion of the soil is allowed and the optimum amount of biomass residue will have to be

left in the ground when biomass residue is slated to become an added feedstock for energy production.

C. Variable supplies of feedstocks to the distillery

As shown in Section A one can expect a surplus of grain in U.S. agriculture to the end of the 80s and new rotation practices will assure feedstock to the distilleries to the end of the century and beyond. Also, as said in Section A, fermentation-fuel-ethanol industry is not expected to have a major impact on present day supply of food made available by the U.S. to the Third World. To increase this supply beyond todays practice is indeed not a question of agricultural production capability but rather of economics and general policy, and the real difficulties are the answers to questions like:

(1) The ability of those countries to pay for the grain,

(2) Balance of payments problems in general; Are we going to import expensive oil in order to export cheap grain?

(3) Geopolitical Considerations.

(4) U.S. farm income—Is the farmer going to obtain the price for his grain according to what he thinks that he deserved? Who is going to pay for the difference?

It is the answer to these questions rather than the problems raised by Mr. L. Brown that will have an impact on the supply of grain. Weather and climatic uncertainties are to be reckoned with too, but then this is part of an agricultural production as old as agriculture itself and other industries, besides the ethanol distilling industry, will have to deal with such uncertainties also. The distilling industry may be more fortunate than other industries, e.g. the bread baking industry, in this respect. The distillery could be constructed so that different feedstocks are possible and when for some reason one feedstock becomes unavailable a different feedstock, if available, could then be used.

VI. CELLULOSIC BIOMASS AS A SOURCE FOR ETHANOL PRODUCTION

The single most important cost in the economic analysis of ethanol production is the carbon source. Cellulosic biomass is expected to cost less than starch and sugar materials and promises to have available a larger reservoir of primary material. As a result cellulosic biomass could have major impact as a raw material for production of alcohol (DOE, 1979). Cellulosic biomass contains approximately equal parts of cellulose, hemicellulose, and lignin (cellulose and hemicellulose, and lignin (cellulose and hemicellulose are used to produce ethanol). It is expected that the initial impact of cellulosic biomass on ethanol production will begin in the mid 1980s and could be substantial by 1990.

Agricultural residues, particularly from corn and small grains, offer a supply of cellulosic biomass that could be collected and utilized. Currently, this valuable residue is returned to the soil. Crop residues play a vital role in agriculture by controlling soil erosion, preventing rapid water runoff, maintaining soil organic matter and soil structure, providing soil nutrients (N, P, K. etc.) and protecting other environmental qualities. For these reasons, agronomists and other agriculturalists recommend that corn residues, for example, be harvested only on land with a 0–2 percent slope. Furthermore, the suggestion was made that, for each acre, at least, 1500 lb of the 5000 lb of corn residues should be left on the land and conservation tillage employed. It is estimated that about 3500 lb of corn residue per acre could be removed from about 20 percent of the land currently used for corn, i.e. land with a slope of 0–2 percent (Gupta et al., 1979). In addition, 1200 lb of small grains residue per acre could be removed from 25 percent of the land used for small grains, primarily wheat. These estimates assume that careful conservation practices would be employed and nutrients removed would be added back as commercial fertilizer. Professor Pimentel further suggests that if a cover crop were planted on corn fields at the end of the season, then all of the corn residue (about 5000 lb) could be removed from about 30 percent of the land (e.g. land with 0–5 percent slope) currently used for corn production. The estimated potential alcohol production from crop residues as estimated in the ERAB report is about 1.9 billion gal. per year. A higher potential of cellulosic residues is provided by the study team at Purdue University Laboratory of Renewable Resources Engineering, headed by Professor Tsao, that estimates the annual output of cellulosic residues (corn cobs, bagasse from sugar cane, straw, etc.) as 1 billion tons per year.

The cost and energy input for collecting and transporting crop residues are significant; as such one could foresee that agricultural residues could initially be used more economically for the purpose of direct combustion to fuel the ethanol distillery for small scale on-farm ffe production.

The use of conservative agronomic practices for use of crop residues should be obligatory to avoid soil degradation, just as well as one could argue for the case that the use of crude for the purpose of the production of high octane unleaded gasoline should be forbidden so that one can decrease the dependence on imported crude. In any case, there should be close monitoring of soils used in this fashion to assure that degradation is not occurring. In the case of forest biomass destined for conversion to alcohol, the environmental problems, however, have not been investigated well and require a great deal of research before any major program is considered in using forest residues and products for ethanol production (Pimentel et al., 1979).

Production of alcohol from biomass must be considered on a regional basis. Generally, those regions with the most favorable growing conditions should have the greatest quantities of residue available. Crop residues, for example, for use in alcohol production, are available in the major grain-growing areas. Likewise, regions well endowed with forests should be identified with wood conversion facilities.

Cellulosic biomass, especially forest products, has a lower potential loss from pests and spoilage than grain and sugar crops and is capable of longer storage under less rigorous conditions than crop products.

Professor Pimentel suggests that the energy input for collection and transport of corn residue is estimated at 200,000 Btu per acre (ERAB). In addition, the fertilizer value of this corn residue is calculated at about 1.6 million Btu. Thus, the total cost in energy for removing the corn residue is about 16 gal. fuel equivalents per acre. This cost must be assessed against the potential energy benefits (140 gal of alcohol per acre) of utilizing corn residues.

Forest residues and products provide a major biomass resource with a potential annual yield of pure ethanol of about 20.5 billion gallons per year (Pimentel et al., 1978). The extent to which forest biomass can be utilized depends strongly on research and development of hydrolysis and conversion technology into commercially viable production routes.

The technology available today for production of ethanol from cellulosic biomass utilizes acid hydrolysis to produce sugars that are fermented to ethanol. This technology is practiced by only one commercial firm as a pilot plant operation (DOE, 1979).

Processes for improved use of cellulosic biomass are being investigated. They include: improved methods for acid hydrolysis, the use of enzymatic hydrolysis of cellulose, pretreatment of biomass to enhance hydrolysis and direct fermentation of cellulosic biomass to ethanol. In these processes, the cellulose and hemicellulose are converted to liquid fuels and the combustion of the remaining lignin will provide the process energy. Thus, the utilization of cellulosic biomass probably would not require the input of nonrenewable fuels (Hsu et al., 1980).

With presently emerging technology, we can expect to see implementation of cellulosic plants for ethanol production in the mid 1980s. With improved technology there is the potential for significant production of ethanol by 1990. In addition, technology is under development to gasify cellulosic biomass (SERI, 1979). Because of the large size requirement for scale economy of gasification plants, it is likely to be difficult to supply sufficient biomass without major shipping penalties and mixed feeds of coal and biomass may be used to produce synthetic gas for methanol production.

Because of the relatively low cost and widespread availability of cellulosic materials, they are, in the long run, with successful technical development, expected to be the most important biomass material for fuel alcohol production.

VII. METHANOL PRODUCTION FROM COAL

Methanol production technology from coal is currently available outside the United States and methanol production technology from natural gas is available commercially in the United States.

The technologies of coal gasification are known and were developed during WW II in Germany as were the processes for methanol synthesis (Bailey, 1979). Considering the fact that no plants have yet been built in the United States it should be recommended that a program for the construction of methanol from coal prototype plants allow "Learning curve" improvements and needed research and development in the coal gasification step. Commercial production of methanol from coal can then be foreseen by the turn of the century. The commercial conversion of methanol to gasoline will not make economical sense for several decades to come. Though, as claimed by Mobil Oil, an 85 percent energy conversion is attainable in the MTG process but in order to obtain this

a volumetric contraction to less than 50 percent of the volume of methanol has to occur (using Mobil data one would expect a decrease of the volume of gasoline produced from methanol to 42.5 percent of the volume of the methanol. This because of the ½ energy content of the methanol as compared to gasoline). Considering that the methanol can be blended with gasoline with good results, and in effect be used as an octane improving additive similarly to what was said above about ethanol, one is losing a major part of the energy efficiency of the methanol when converting it to gasoline. Rather one should try to improve the miscibility of methanol with gasoline and Sun Oil Co. has lately suggested that it has obtained good results when preparing octane improving additives via mixtures of methanol with teritary butyl alcohol (TBA). This last observation suggests also that if one were to use the methanol for octane boosting purposes one need not go all the way to prepare the methyl tertiary butyl ether (MTBE).

Several variants for the production of methanol from coal have been evaluated by DOE (DOE 1978, Schreiner, 1978). Examples suggested are: (1) lignite could be used in a Koppers-Totzek gasification system coupled with the ICI (Imperial Chemical Industries) methanol production process with a process efficiency of about 50 percent (2) Illinois No. 6 coal was suggested an input in a Texaco partial oxidation gasification system coupled with a Chem System methanol conversion process.

Production of methanol from coal carries with it potential environmental problems of major concern, land damage, air and water pollution, and increased production of carbon dioxide. The last problem is something that has yet to be understood.

The cost of production of methanol from coal though, calculated by different DOE contractors, is in effect not known yet exactly as no plants have yet been built in the U.S. Proposals have been made that suggest that it is possible to produce methanol from coal at a cost much lower than ethanol from grain. These proposals are based on large scale conversion plants that will take a long time to build and do not include costs of the capital, unpredictable but foreseeable cost overruns and infrastructure costs (railroads, community construction expenses, social and environmental costs, etc.).

If it were so that methanol can be produced now at about one half to one third the cost of ethanol production from grain, it is hard to see why the proponents still need "adequate guarantees for product revenue". Though realizing the full future importance of the potential for methanol from coal, it is advisable to keep this subject in the right perspective by recognizing that this technology is further down the road when compared to fermentation-fuel-ethanol.

Attachment VIII-A: Energy Balance For Ethanol Production For Corn As Seen by the ERAB Group

TABLE 1.—ENERGY BALANCE FOR ETHANOL PRODUCTION FROM CORN[1]

[Thousand Btu per gallon[2]]

	Best available technology, high quality plant fuel	Future coal-fueled plant
Consumed:		
Fermentation/distillation[3]	69	[4] 0
Farming[5]	45	45
Total	−114	−45
Produced:		
Ethanol	[6] 76 (130)	[6] 76 (130)
By-product animal feed[7]	11	11
H value of crop residue[8]	3	3
Total	[6] +90 (+144)	[6] +90 (+144)
Net	[6] −24 (+30)	[6] +45 (5+99)
Refinery credit	+8	+8
Total	[6] −16 (+30)	[6] +53 (5+99)

[1] Corn is the grain crop used for this example because it is the most common food crop used to produce ethanol. Other grain and sugar crops could be utilized for ethanol production but, like corn, all require a significant energy input for culture (Pimentel, 1980) and similar energy inputs in the fermentation distillation process (EJ. Honohan, 1979, personal communication, Pfizer, Inc.).

[2] For consistency, all heating values are expressed as LHV (low heating values).
[3] Energy inputs for fermentation distillation vary depending on size of plant and technology employed and these range from 40,000 to 148,000 Btu (Scheller and Mohr, 1976; Reilly, 1978; Katzen, 1978; David et al., 1978; ACR, 1978; DOE, 1979b; Kertzmark, 1979; Weisz and Marshall, 1979; Chambers et al., 1979). For a modern 50 gal per year ethanol plant about a 69,000 Btu input is calculated per gallon of ethanol product using vaper recompression evaporators (about 100 Btu lb of water evaporated) E. J. Honohan, 1979, personal communication, Pfizer, Inc.).
[4] Assumed to be zero because coal is substituted for oil and gas.
[5] Energy inputs for raising corn vary depending on the technology employed, soil quality, rainfall, pest attack, and other factors. Reported energy inputs for corn production prorated per gallon of ethanol range from 35,000 to 74,000 Btu (Scheller and Mohr, 1976; ACR, 1978; Reilly, 1979; DOE, 1979b; Kertzmark, 1979; Weisz and Marshall, 1979; Chambers et al., 1979). An average energy input for corn used to produce a gallon of ethanol is at least 45,000 Btu (Pimentel and Pimentel, 1979).
[6] The value in brackets assumes a mechanical equivalency, i.e., that a gallon of gasohol will move an automobile as far as a gallon of gasoline. A gallon of gasoline has an equivalent of 114 Btu's or an equivalent of crude oil is 130,000 Btu's. A serious question exists concerning the assumption that a mechanical equivalent of gasohol as gasoline exists.
[7] Energy credit is taken for distillers grains, which are produced as a by-product and used for animal feed. Reports of credits range from 1,000 to 52,000 Btu per gallon produced (Scheller and Mohr, 1976; DOE, 1979b, Kertzmark, 1979; Weisz and Marshall, 1979; Chambers et al., 1979). For a 50,000,000 gal per year ethanol plant with a well-designed during facility, a credit of about 11,000 Btu was calculated.
[8] Crop residue contains about 1 percent nitrogen, 0.1 percent phosphorus, 0.9 percent potassium, 0.6 percent calcium (NAS, 1978). Energy value as fertilizer was calculated to be 3,000 Btu.

The Scientific Profiles of the Members of the ERAB Gasohol Study Group [1]

A preliminary study

The D.O.E. Research Advisory Board, Gasohol Study Group included the following members:

The Chairman was Prof. David Pimentel. Professor Pimentel and two additional members of the Gasohol Study Group Dr. Richard Hinman and Dr. Thomas Stelson are regular members of DOE/ERAB.

In order to form the Study Group, Profesor Pimentel invited four additional members who are not regular members of the ERAB—Dr. Paul Burg Weisz, Prof. Charles Leland Cooney, Prof. Jack Marion Spurlock, and Prof. William Alfred Scheller.

In order to establish a scientific profile for all the members and staff of the Study Group two data-base computer listings were used to obtain the lists of scientific publications. These lists were then studied for relevance to the subject of alcohol fuels. For all members of the Study Group, except one member, the lists cover the years 1972–1980. The one exception, the list covers the years 1966–1971 as no publications were recorded for the years 1972–1980.

The listings in American Man & Women of Science were checked for general information (AM&WS).

Professor Pimentel is an entomologist who has produced important work in the analysis of energy inputs in agriculture.

The majority of his publications deal with pesticides and he was right to point out that the Green revolution has been effected by an increased use of fertilizers. Somewhat out of line with his main interest are two quite resembling publications: "Biological Solar Energy Conversion and U.S. Energy Policy" in BioScience June 1978, and "Biomas Energy Conversion as Alternate Energy Source" in Compost Science/Land Utilization, January/February 1979. Both papers state that biomas energy is costly in terms of energy expended in the conversion process. The papers suggest low confidence for energy production from such primary materials as agricultural residues or energy farming and conclude that though possible to produce energy via agriculture and forestry "based upon their analysis, the researchers conclude that we are presently obtaining greater gains from biological solar energy conversion through agriculture and forestry than we will ever gain from biomass conversion to energy". One can thus say that Dr. Pimentel was known to be less than enthusiastic about the use of biomass for energy production, furthermore one could say that the Professor's career is rather in the area of use of energy in agriculture than in the production of energy via agriculture. This observation holds also when reading the volume "Food, Energy and Society" written by David and Marcia Pimentel.

Dr. Pimentel is listed in AM&WS and the above observation is sustained.

Studying the jackets of two Pimentel books on Pest Control, published by the American Association for the Advancement of Science one sees that Prof. Pimentel became a member of ERAB in 1978 or 1979.

[1] Prepared for the use of DOE by Pincas Jawetz, Independent Consultant on Energy Policy, New York, N.Y.

Dr. Hinman has no publications listed since 1971 when he published a study on organic nitrogen chemistry while at the Dept. of Chemistry of the Illinois Institute of Technology. Prior to this he published in 1967–1968 papers relating to other nitrogen compounds while working for Union Carbide.

Presently Dr. Hinman is Vice President for Chemical R&D at Pfizer Inc.

No evidence was found in the literature to ascertain his role in the Study Group, though as told by Professor Scheller before a Congressional Caucus, Dr. Hinman prepared the Pie-Chart figure 1 in the report.

Dr. Hinman is not listed in AM&WS.

Dr. Stelson is a civil engineer and in the data base only one publication was found: "Wood and Energy" printed in the Journal of the Technical Association of Pulp & Paper Industry and stemming from a presentation at the TAPPI 1980 Annual Meeting in Atlanta, Georgia.

The main subject of this paper was the energy conservation success of the pulp and paper industry which is using now wood for internal energy needs.

Dr. Stelson is listed in AM&WS and among his interests, mostly unrelated to the task of the study group, one—Transportation and Systems engineering—is appropriate to the task of a gasohol study.

The non ERAB members of the Study Group, selected for their potential contributions to the study:

Dr. Weisz has had an illustrious career in catalysis, diffusion phenomena and petroleum processes. His studies include "Demetalization of Petroleum", "Catalytic Cracking", "Methane and Aromatics", "Petroleum Refining Catalysts", "Naphtha Processing". His experience with refinery questions is undeniable and therefore one wonders why the question of reformates and requirements of crude to produce higher octane values at the refinery, and the place of ethanol in displacing these needs, was not touched in the study.

Dr. Weisz, who edited several volumes on Catalysis has written on the "Catalytic Production of high grade fuel (gasoline) from Biomass" as well as "Conversion Methanol and Synthesis Gas to Hydrocarbons". He was in effect in charge for establishing the Mobil Methanol to Gasoline process.

Dr. Weisz has participated in September 1978 at the National Meeting of the American Chemical Society in a "Symposium on U.S. Energy Policy Situation—1978", chaired by Dr. Pelofsky. Dr. Weisz' presentation was titled: "Analysis of a Dream: Biomass". Dr. Weisz, like other high officials of the Mobil Research & Development Corp. has thus stated previously his negative attitude to gasohol. The Gasohol study does not reference the "Dream" paper.

In 1980 Dr. Weisz has entered a new phase in his work. He published in Chemtech a series of interesting society oriented articles: "Sacred Cows and Energy", "Societal Kinetics", "Population and Energy", "Golden Ideas—Sobering Science"—a new outlet for his creativity, quite different from his very technical papers in past years.

Professor Conney is the most prolific writer among the members of the Study Group. His work is on continuous microbial culture, microbial protein production anaerobic digestion and with other members of the M.I.T. faculty he was involved in studies of cellulose hydrolysis and ethanol production. One can in effect wonder why his interests had no stronger impact on the Study Group report.

He is listed in AM&WS.

Professor Spurlock has only one publication listed in the data-banks: "Usage of Graph-Theoretic Methods in Chemical Venture Analysis".

He is Associate Director of the Applied Science Laboratory at Georgia Institute of Technology where studies are being performed on the production of ethanol from cellulose though there is nothing we could find that would indicate he is an active part of this program.

He is listed in AM&WS.

Professor Scheller has had publications on gasohol starting 1974 and was involved with all aspects of the subject. He has had also experience in catalysis and in working with an oil company. According to his own statement he has not had an impact on the writing of the report—in any case such an impact is not visible when one studies the report.

He is listed in AM&WS.

SUMMARY

The first impression of this preliminary evaluation, though possibly incorrect, seems to indicate that out of the seven members of the team four members were in a position to make contributions to the subject of the study. Out of these four members the Chairman and Dr. Weiss were known beforehand to have a negative attitude to the subject.

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