DEPARTMENT OF ENERGY GASOHOL POLICY

HEARING

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON GOVERNMENT OPERATIONS HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

SECOND SESSION

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DEPARTMENT OF ENERGY GASOHOL POLICY

MONDAY, JULY 28, 1980

HOUSE OF REPRESENTATIVES,
ENVIRONMENT, ENERGY,
AND NATURAL RESOURCES SUBCOMMITTEE
OF THE COMMITTEE ON GOVERNMENT OPERATIONS,
Lafayette, Ind.

The subcommittee met, pursuant to notice, at 9 a.m., at the Farm Credit Building, Lafayette, Ind., Hon. Toby Moffett (chairman of the subcommittee) presiding.

Present: Representatives Toby Moffett, Floyd J. Fithian, and Joel Deckard.

Also present: Steven J. Engelmyer, counsel, Environment, Energy, and Natural Resources Subcommittee.

OPENING STATEMENT OF CHAIRMAN MOFFETT

Mr. MOFFETT. The subcommittee will come to order.

The Subcommittee on Environment, Energy, and Natural Resources has an ongoing responsibility to oversee the Department of Energy as it implements our Nation's energy policies. This morning we are pleased to be here in Indiana to examine the Department of Energy's policies regarding one of the most promising alternatives to our current debilitating reliance on foreign oil, and that is the use of gasohol.

The subcommittee, led by Congressman Floyd Fithian has become very concerned in recent weeks about Department of Energy gasohol policy. That concern was triggered by the DOE involvement with a controversial advisory report to DOE which favored coal-based methanol over grain-based ethanol for use in gasohol.

At the outset, I would like to express the appreciation of the entire subcommittee for the outstanding work of Congressman Fithian in promoting gasohol as an alternative fuel source. His leadership in this area has been a great contribution, beyond the subcommittee, throughout the Congress, particularly in the House of Representatives, as we have grappled with our Nation's energy problems. We are truly indebted to him for his efforts, and we are particularly grateful to him for his leading role in the investigation which brings us here this morning.

On May 2, 1980, the Energy Research Advisory Board transmitted to the Secretary of Energy, Secretary Duncan, a report on gasohol prepared by its Gasohol Study Group. The report was immediately criticized as a biased, haphazard, and unscientific attempt to explore the many complex issues involved in the production of gasohol. The

most controversial aspect of that report was its preference for coal-based gasohol over grain-based gasohol.

A memo to the Secretary of Energy from Steven Potts, the former Director of the Department's Alcohol Fuels Office, called the report:

> 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.

Bert Greenglass, the current Director of DOE's Alcohol Fuels Office, will testify this morning concerning the Department's response to that advisory panel report and what effect, if any, that report has had on the Department's support for grain-based ethanol as a major component of our Nation's gasohol policy.

We will also hear a critique of the advisory panel report from experts of both Purdue University's Laboratory of Renewable Resources Engineering—which I might add is one of the country's leading alcohol fuel research facilities—and the National Alcohol Fuels Commission.

A crucial but overlooked aspect of the controversy surrounding the advisory report is the process by which it was issued. An important but little-known law, the Federal Advisory Committee Act, sets out specific procedures to insure objectivity and public input into all DOE advisory committee reports. The subcommittee has evidence which seems to indicate that a top-level DOE official violated that act in conjunction with the compilation of this advisory report.

The Chair might add that beyond the action surrounding this particular advisory committee, there is of course the larger issue of what becomes of information and data as advisory committees deal with it, the larger issue of Federal advisory committees and their role, and the even larger issue raised by these hearings and the particular report in question of what our alternative energy policy will look like, whether it will be one dominated by a handful of major companies or whether it will be one that takes advantage of the vast array of options and brings into play the tremendous innovation and enterprising spirit that we have in this country of ours.

Tina Hobson, the Director of the Department of Energy's Office of Consumer Affairs, has responsibility for assuring compliance with the Federal Advisory Committee Act. She will testify whether any violations of this act occurred in the issuance of the advisory panel report and will also address the steps being considered to insure that future Department of Energy advisory reports are in full compliance with that act.

Before calling on Tina Hobson, however, the Chair recognizes the gentleman from Indiana, Mr. Fithian.

Mr. FITHIAN. Thank you, Mr. Chairman. I want to thank you for coming and to welcome you to Indiana and welcome my colleague from Evansville, also a member of the panel who has worked very hard and long on the whole matter of energy problems and potential in this country.

Let me say at first that it is in the Midwest where most of the gasohol will be made and a fair amount of it will be used. The first commercially available synthetic fuel is ethyl alcohol, and we should not overlook that; nor should we overlook the fact that 80 percent of it is made less than 100 miles from where we are sitting this morning.

Many of us in the Midwest have come to look upon gasohol not only as an important source of local fuel but an important offset and reduction to our dependence on Arab oil and imported oil.

The report that's under question this morning is more important, I think, than most of the public realizes in that it sets the tone and, if correct, will essentially derail alcohol fuel in the United States, for the report challenges the potential contribution of gasohol toward solving our national energy problem. It suggests that the cost of energy efficiency presents serious, perhaps insurmountable problems, to any plan for large-scale gasohol production in the United States.

If these findings then were accurate and if they are going to be used as the basis for the Department of Energy alcohol fuel policy, then the recent congressional initiative to promote gasohol production and use and the $1.45 billion that was put in the synthetic fuels bill were mistaken notions and wrong thrusts of Congress. If, on the other hand, these findings which have been now given to the Secretary of Energy are inaccurate as I believe they are inaccurate—and several prestigious technical reports which preceded the ERAB report seem to imply that they are inaccurate—the record then should and I would say must be set straight, and our national gasohol program should be set into motion without further delay.

One of the things that I hope comes from these hearings is a clarification and the setting of the record straight on this basic energy initiative.

Shortly after the gasohol report was released last May, a variety of very serious charges were made, ranging from alleged violation of Federal laws, to which you have referred, all of the way over to protecting a major competitor and opponent of alcohol fuels, of ethyl alcohol fuels—that is, Mobil Oil Corp. has charged that that helped bias the report. The question that might arise and should arise is: Why should the Department of Energy put them, the chief opponent of alcohol fuel development in the whole United States, on the panel in the first place? I think that's a question that somebody should answer.

The second question is whether or not the basic report is wrong and, if so, how wrong and what does this really mean for the future policy of alcohol fuels in the United States?

I think that the former Director of the Office of Alcohol Fuels, Steven Potts, summarized it well when he said the controversy of this report focuses upon the objectivity of the panel and the effort casts doubt upon the objectives, independent judgment, and scientific character of ERAB itself and upon the utility and viability of ERAB as an advisory panel providing scientific judgment to the top-level Government policymakers. So it is important, I think, that we assess this; and it's important that we return a credibility to Government scientific advisory panels if we are to be able to move forward.

If the disputed findings of the ERAB report are found to be inaccurate, the Energy Department should clarify its policy regarding alcohol fuel production and indicate whether or not the report substantially influenced that policy.

These are the substantive questions that I would hope the hearing unravels this morning.

I thank you, Mr. Chairman.

Mr. MOFFETT. The Chair recognizes the gentleman from Indiana, Mr. Deckard.

Mr. DECKARD. Thank you, Mr. Chairman.

I would first like to commend you for these hearings, and I am especially pleased that you have agreed to explore the subject here in our Hoosier State which has already made great contributions toward the development of alcohol fuels. There is no need, at this point, for me to go into the importance of developing alternative sources of energy except to say that the expanded promotion and use of alcohol-based fuels would be good not only for the economy of our State of Indiana but for the security of the United States as well.

Thank you, Mr. Chairman.

Mr. MOFFETT. At this time, the Chair welcomes our first witness, Tina Hobson, Director of the Department of Energy's Office of Consumer Affairs, accompanied, I believe, by Kenneth Cohen from the Department of Energy's Office of General Counsel.

As I think you know, it is the practice of the subcommittee to swear in all witnesses so as not to stigmatize any witnesses. Would you please stand and raise your right hand? Mr. Cohen, will you be testifying?

Mr. COHEN. I——

Mr. MOFFETT. You may be; so, please raise your right hand.

Do you swear to tell the whole truth and nothing but the truth, so help you God?

[Chorus of "I do."]

Mr. MOFFETT. Thank you both for being with us.

I think we are going to need a microphone, if the staff would take care of this.

Ms. HOBSON. A mike?

Mr. MOFFETT. Please.

Ms. HOBSON. I have a fairly loud voice.

Mr. MOFFETT. I understand that you had a little problem with your luggage.

Ms. HOBSON. Yes.

Mr. MOFFETT. It has arrived, I believe.

Ms. HOBSON. Yes, it arrived. Thank you, very much.

We got here about 1 minute after 9, but we learned a lot about this city in the process, including trains.

Mr. MOFFETT. Very good.

Without objection, your entire prepared statement will be entered into the record and considered a part of the record. You may, if you like, paraphrase that statement, and then we will move to questions by the subcommittee members.

STATEMENT OF TINA HOBSON, DIRECTOR, DOE OFFICE OF CONSUMER AFFAIRS; ACCOMPANIED BY KENNETH COHEN, DOE OFFICE OF GENERAL COUNSEL

Ms. HOBSON. All right. I'd be happy to. I brought some extra copies here, if anyone is interested.

Mr. Chairman and members of the subcommittee, thank you for the opportunity to appear here today.

I invited Mr. Cohen to come with me, because I don't want to play lawyer, and this is a rather technical and complex area, the Federal Advisory Committee Act.

I also want to mention that Mr. Holmberg is here today. He will be participating with Mr. Greenglass in subsequent testimony; however, he was in our office during this period and can also answer questions since he was, in terms of consumer affairs, involved in representing farmers and farm communities. He participated in the initation of the Office of Consumer Affairs in the whole alcohol fuels area, particularly as it relates to farmers and farm communities. So I want him, if I say something in error, to please feel free to correct me.

All right; in terms of what we are talking about today, I think you want to examine possible violations of the Federal Advisory Committee Act—FACA—which may have occurred in relation to the recent gasohol study report. As you know, I am Director of the Office of Consumer Affairs and I am responsible to you and to Congress for implementation of FACA.

DOE is in the process of resolving several key policy issues relating to advisory committee management. One of the issues concerns the extent to which all subgroups of DOE advisory committees should be subject to FACA.

In accordance with a DOE General Counsel opinion of December 4, 1978, subgroups of advisory committees may have members who are not on the parent committee. These subgroups are not subject to the Federal Advisory Committee Act as long as they provide advice or recommendations only to their parent committee and not directly to a Federal agency or official. I think this is key here. Although unchartered subgroups are legal in terms of our General Counsel opinion, they may be misused.

The Gasohol Study Group of the Energy Research Advisory Board was established in November 1979. The membership consisted of—and note this—there are actually three members of the full committee: Piementel, Hinman, and Stelson. Stelson at that time was under consideration as Assistant Secretary for Conservation, and so on. All right; the others were not members of the full advisory committee.

There was only one meeting of the Gasohol Study Group of which I am aware. It was held on December 10 and 11; notice of the meeting was not published in the Federal Register.

I learned of the Gasohol Study Group meeting on December 10 after it was already in session. I understand that Bill Holmberg learned of it earlier and made an attempt to put a farmer on that committee. You can ask him about that if you choose.

There were no plans for public participation or the making of a verbatim transcript. Although public participation and making a verbatim transcript may not have been legally required, I believed that the issue of alcohol fuels was very significant and of great public concern. At that time, we were developing the Energy Consumer on Alcohol Fuels and recognized the importance of this subject to the citizens.

Therefore, I personally took a court reporter to the meeting on the second day and had a transcript made.

On December 19, I met with Ed Frieman, Director of Energy Research, his Director, Office of Advisory and Liaison Programs, Bill Bartley, and Sol Buchsbaum, Chairman of the Energy Research Advisory Board. We reached an agreement on some procedures related to subgroups. Part of our agreement was assurance by Dr. Buchsbaum that reports would be submitted in preliminary draft form to ERAB for approval before they are submitted to DOE. This would insure review by a balanced committee that includes three consumer members, one of them being Amory Lovins, the other Grant Thompson, and the other Tom Cochran from NRDC.

On December 19, 1979, John Deutch, then Under Secretary, forwarded a draft of a memo to the Secretary, dated December 17—remember, that was only 7 days following the meeting—to several DOE officials for comment. The draft memo contained recommendations for 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 we did not want to see happen. Therefore, I called Dr. Buchsbaum and pointed out that in spite of our verbal agreement, the gasohol report would apparently have an impact on DOE before it was approved by the full ERAB. Remember, the full ERAB committee did not meet until February; February 7 and 8 was the first meeting.

I also wrote a memorandum to John Deutch on December 20, calling attention to the implications in his draft memo of December 17 that the results of the Gasohol Study Group were approved by the full board.

At the May 1 and 2 meeting—that's after the February 7 and 8 meeting—the second meeting, the gasohol study report was on the agenda. Amory Lovins, a member of ERAB, advised me a couple of days before that he was not notified of the May 1 and 2 meeting. Amory Lovins has since indicated that all his back mail has been received, and there was still no notice of the May 1 and 2 meeting. Incidentally, he did file a minority report.

I took one of the people Mr. Lovins recommended as his alternate, Ken Bossong of the citizen's energy project, to the meeting. However, Dr. Buchsbaum would not allow Mr. Bossong to serve as an alternative although Richard Alban had been listed as an alternate to Roland Schmitt, General Electric, at the February 8, 1980, meeting. I want to add that Dr. Buchsbaum contends that Mr. Alban was in fact present, not as an alternate, but as a resource person on a specific report because of his participation in its preparation. Mr. Lovins has since sent a letter to the Secretary indicating his disagreement with many of the findings in the gasohol report.

In order to accommodate the special need to obtain advice directly on short-term programs, which we recognize in the scientific community as important, when time seems of the essence, to allow increased public participation, and still comply with the Federal Advisory Committee Act, my office suggested and our General Counsel formally recommended to OMB, very recently, that short-term committees, less than 1 year, be exempted from the requirement that they be chartered, but continue to require that they comply with all other provisions of FACA and implementing regulations. That's such as

notice of the public meeting, public participation, a listing in the annual report to Congress, but it simply will make the law more flexible.

This concludes my testimony, but I think those particular steps were important for you to understand.

Mr. MOFFETT. Thank you very much for that testimony, Ms. Hobson.

The Chair at this time, as is the practice and custom of the subcommittee, will recognize members for questioning under the 5-minute rule.

At this time, the Chair recognizes the gentleman from Indiana, Mr. Fithian, for 5 minutes.

Mr. FITHIAN. Thank you, Mr. Chairman. Ms. Hobson, when Under Secretary Deutch sat down with members on the 10th and the 11th, does this not constitute the giving of information by a subcommittee to a Federal official? Would not Mr. Deutch be considered a Federal official?

Ms. HOBSON. I am going to ask Ken to answer that.

Mr. COHEN. Yes, sir; Mr. Deutch would be considered a Federal official. The fact that a Federal official meets with a group of people does not necessarily mean that there is an advisory committee situation, for instance.

Mr. FITHIAN. I understand that; but if then, subsequent to that meeting, this Federal official transmits to the Secretary of the Department the essence of the report prior to its being cleared all of the way up through the full Energy Research Advisory Board, doesn't that violate FACA?

Mr. COHEN. It certainly raises not only one eyebrow but two eyebrows, but I would have to have a more concrete feel of the facts.

Mr. FITHIAN. Well, let me see if I can clarify this.

The advisory board's purpose was to get at and obtain the best of the scientific information and data. You probably are aware, or perhaps you aren't, that this was the most crucial period in which alcohol fuels policy was being fashioned, for it was on January 4 that the President announced the embargo; and the farm community, and particularly those of us in the farm bloc, opposed that. We proceeded then to discuss with the White House alternative issues, and I myself met with the Chief Adviser to the President.

At that point, when we transmitted our input from the legislative side, if I am not mistaken from what Ms. Hobson has just recounted to us, Mr. Deutch—long known as an opponent of alcohol fuel, along with Mobil Oil—was doing the other thing which was to short circuit, as I understand the time sequence here, to short circuit the normal safeguards that are built into the FACA by, one, meeting with them on the 10th and the 11th and, two, taking the essence of that and transmitting it to the Secretary at the time when the Secretary was under great stress to fashion the national alcohol fuels policy, for it was, as you remember, on January 11 that the President enunciated his alcohol fuel goals.

So it seems to me, Mr. Chairman, and I could be wrong, but it seems to me that the very coincidence of the timing of what was going on at the White House and what was going on with the Department of Energy at this point in fashioning both the goals in terms of amounts of alcohol fuel that would be produced and the policies which were

reached there, it seems that this was a very clear violation of what an advisory board is supposed to be in the first place. It seems that those two actions—one, meeting with the committee; and then, two, transmitting to the President's chief official on alcohol fuels the essence of the report—seem to have said that the Federal Advisory Committee Act is not applicable to the Department of Energy.

Now, am I totally wrong in the sequence of events and the timing of events?

Mr. COHEN. Yes, sir—no, sir, you are not wrong.

I hesitate, though, before a committee of Congress, to say that an official has definitely violated the law, without having full facts. It certainly gives that appearance, but a Federal official can meet with an advisory committee to brief that committee or a Federal official could be communicating to the Secretary findings of fact made by the people rather than advisory recommendations.

Mr. FITHIAN. Well, let me turn to another vein of questioning, because my time will soon expire.

Mr. MOFFETT. Will the gentleman yield at this point?

Mr. FITHIAN. I'd be happy to.

Mr. MOFFETT. I am not sure why you can't say that he violated the law. Is it that fuzzy? Is it that vague?

Mr. COHEN. I haven't heard Dr. Deutch's side of the story. I understand there's a GAO investigation that hopefully will flush out all of the facts.

I have to emphasize again that I not only have one eyebrow raised but two, but I just hesitate——

Mr. MOFFETT. We have the transcript here: minutes of the gasohol study group of the Energy Research Advisory Board, December 10, 1979. It says that at 4 p.m. the entire study group reconvened to review its progress for the Under Secretary. The findings presented to the Under Secretary at the end of the first day included, one, under normal agricultural and market conditions in the 1980–85 timeframe, gasohol production and utilization will displace about 26,000 barrels a day of oil, and so forth and so on.

What's the hesitation here? He violated the act, didn't he? We are not trying to get you to do something unfair or to have you make a conclusion that is not fair, but Congressman Fithian, it seems to me, asked a question that you can give a straight answer to.

Mr. COHEN. Mr. Chairman, the minutes of the December 10, 1979, meeting certainly indicate to me that the act was probably violated, but then the text of the transcript at the following meeting—and I am not a scientist—but after reading the transcript twice, it seems to me that Dr. Deutch perhaps was at that meeting exploring the methodology used by the panel. So, on a one-page summary of the minutes——

Mr. MOFFETT. You are saying at the next meeting they weren't giving him advice?

Mr. COHEN. It's difficult to tell from the testimony. Dr. Deutch certainly was there; he seemed to be exploring the methodology.

The key, or one of the keys, under the Advisory Committee Act is whether the committee is providing collegial consensus advice, and it's difficult for me as a nonscientist to be able to discern whether that's collegial consensus advice.

Mr. MOFFETT. Well, I am not a scientist either, Mr. Cohen, but look at this [referring to a transcript before him]—this is from the next day. I am quoting now from the transcript:

Mr. DEUTCH. Is the $1.20 the selling price?
Mr. HINMAN. It is very otpimistic.
Dr. WEISZ. Methanol is about 40 cents or 50 cents, depending, per gallon.
Dr. HINMAN. If we do it on an equal Btu basis, this $1.20 would have to go up 1.5 times on the Btu equivalent. If we take methanol, it is 40 cents. We have to multiply by 2, so it is 80 cents. So we are talking 80 cents versus $1.20.
Mr. DEUTCH. What is the $1.20?
Dr. HINMAN. That is at the plant gate.

And so forth and so on. Dr Hinman, at another point:

The expectation of new and cheaper technology coming on stream before these plants have finished their useful life.

This is in answer to a question.
And then Mr. Deutch:

Additional incentive for what may be a short-term technology.

All through this, Mr. Deutch says:

These will not use gas, and they will not use oil.
Mr. POTTS. There are some that use coal and wood. They are the smaller ones, not the larger ones.

Mr. Deutch responds:

Are they up in the West?
Mr. POTTS. I cannot tell you that; the people did not give us the specifics.

Does that sound like methodology or does it sound like advice? You don't need to be a scientist to know that that's advice.

Mr. COHEN. The key, Mr. Chairman, from a legal point of view, is whether that advice is collegial and consensus. I think it's important, however, perhaps not to dwell on what some might perceive as legal technicalities. I think what's important is that at least the appearance of the act being violated, I think, is harmful to the Department.

Mr. MOFFETT. I thank the gentleman for yielding. Thank you, Mr. Fithian.

Mr. FITHIAN. I have one question which goes on with your last comment and that is, what is harmful to the Department?

Am I correct, Ms. Hobson, as I look at the documents, that a seat, a spot on the ERAB was essentially saved for Mobil Oil?

Ms. HOBSON. I was not made aware of a memo establishing the ERAB study group, which I say later, which is dated November 21. It does indicate in that memo that there would be one or another of two Mobil people on the committee. So, the appearance, I would have to say, looked like there was going to be a Mobil person on the committee.

Mr. FITHIAN. Mr. Chairman, I would like to request unanimous consent to include the memo from the Acting Director of the Office of Energy Research to the Deputy Secretary, dated November 19, 1979, in setting up the panel, in which I think Ms. Hobson's characterization is correct. It simply announces the people that should be on the panel. When it gets down to the last slot, it says Paul Weisz of Mobil Oil or John McCullah of Mobil Oil. I think it's clear that one seat was saved on the panel for Mobil Oil.

Mr. MOFFETT. Without objection, that will become part of the record.

[The material follows:]

DEPARTMENT OF ENERGY,
Washington, D.C., November 19, 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.

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.

Attachement.

ENERGY RESEARCH ADVISORY BOARD STUDY GROUP ON GASOHOL

Dr. David Pimentel, Chairman,* Cornell University.
Dr. Charles Coonie, Massachusetts Institute of Technology.
Richard L. Hinman,* Pfizer, Inc.
William Scheller, University of Nebraska.
Thomas Stelson,* Georgia Institute of Technology.
Paul Weiz, Mobil Oil or John McCullah, Mobil Oil.

DOE staff support:

Sandy Harris
Conservation and Solar

Robert Rabson
Energy Research

*ERAB members.

Mr. FITHIAN. Perhaps I should ask the other Department witnesses this question as to why that kind of a development would take place.

Ms. HOBSON. Again, we are dealing in an area here where we, as the advisory committee management office, were not notified of the meetings, where members are not picked by DOE but, rather, are picked by the chairman of either the full committee or the subcommittee.

Asking whether DOE approves of this is different from asking if it's a violation of the Advisory Committee Act.

Mr. FITHIAN. I will bring this question back up with other Department witnesses, but it seems to me that we ought to indicate for the record at this time that the chief opponent, in my view and I think in the documents, of the development of ethyl alcohol in the United States is Mobil Oil; and there is a reason for that, if I may be allowed an editorial opinion, Mr. Chairman.

As you know, the development of the methyl production from coal is a chief objective of Mobil, and Mobil sees this as something worthy of investing millions of dollars in research, as we see it as worthy of investing the same amount of money or more from the taxpayers' funds. I do not at this point want to argue that we ought not to develop the methyl production facilities that Mobil is working on.

What I resent, first, is the kind of public stance that Mobil is taking in trying to crowd others from the field; but what is even more reprehensible, I think is when the Department of Energy seems to go along with this by "saving a spot on the ERAB panel" for a representative of Mobil. It's well known, of all the oil companies, that Mobil is the chief opponent of this whole development of alcohol fuels; and we find in the Department's records itself an effort to clearly save one spot for them on the panel. It seems to me like it's putting the fox in charge of the chicken coop.

I believe that's the balance of my time.

Mr. MOFFETT. The gentleman's time has expired.

The Chair now recognizes the gentleman from Indiana, Mr. Deckard.

Mr. DECKARD. Thank you, Mr. Chairman. Ms. Hobson, on page 2 of your statement you said that you learned of a Gasohol Study Group meeting on December 10 after it was already in session, and there were no plans for public participation or the making of a transcript, and, as a matter of fact, it was at your initiative that we have a transcript of the hearing; otherwise, we would not.

When you did learn of that meeting, what contacts did you have with the members of that panel and what explanations, if any, did they offer with regard to their conduct, the manner in which the members took their responsibilities?

Ms. HOBSON. I learned about the meeting on the evening of the 10th, and I didn't stop to ask about their comments. I simply got a court reporter and took her into the meeting on the 11th and no one literally said anything or objected. I said this is just something that's very important that we have a public transcript of this meeting. Beyond that, nothing was said by any member present, and no one objected to the transcript.

Mr. DECKARD. What discussions did you have after the meeting?

Ms. HOBSON. After the meeting, there again were considerable discussions over the General Counsel's interpretation of FACA and whether or not that subcommittee or any other, the fusion, the weapons lab study groups, any of the other that are a part of ERAB, are responsible under FACA for announcing meetings, having a court reporter or minutes or the other requirements. I want you to know that both Ken and I are here to support the Secretary and the agency in that this is still under discussion within the agency and is coming up as an option for the Secretary's decision.

Mr. DECKARD. Was it their feeling that they had no obligation to meet those requirements?

Ms. HOBSON. That's correct.

Mr. DECKARD. I know that you don't feel as though you want to make a specific charge of illegality, but this is at best an abuse of the proper policy in the formulation of public policy. Has this happened

before, to your knowledge, in any other area of DOE covering any other subject? Have you found yourself, as the Director of the Consumer Affairs Division, shut out of DOE meetings and policy deliberations?

Ms. HOBSON. No. I did under Secretary Schlesinger; but Secretary Duncan is much more concerned about involving the public in the process of decisionmaking and programs within DOE. We are not shut out.

I would like to state that this whole concept of having subgroups with members not selected by DOE came up as a result of the National Petroleum Council Advisory Committee's moving from the Department of the Interior to the Department of Energy, when it became the Department of Energy; and the National Petroleum Council has a number of subgroups—again, it has 96 on the full committee and a number of subgroups—who have had 137 meetings in 1 year, different subgroups on different issues that do not have members of the main group, of the full body, so that the decision, the November 4 memo by the General Counsel, referred to the National Petroleum Council Advisory Committee, not to ERAB.

The other subgroup that came under severe criticism was the Weapons Lab Study Group of Los Alamos and Lawrence-Livermore, where some of the meetings were not open to the public; there was a sense of secrecy. There again, whether it was illegal or not, I cannot judge, but it certainly gave the public the idea that we were trying to hide and misuse the Federal Advisory Committee Act; and that is the issue the Secretary currently is trying to resolve.

Mr. DECKARD. Just one final question. In the chairman's opening statement, he quoted the former Director of DOE's Alcohol Fuels Office, Steven Potts, as saying:

> The report was an attempt to railroad the gasohol issue by enveloping a biased and fully substantiated report in the cloak of supposed scientific judgment of the Energy Research Advisory Board.

I wonder if you would agree with that characterization that Mr. Potts has made.

Ms. HOBSON. I think from a public point of view—and again, this is an issue that we know in our office and you know in Indiana is a major public issue of public interest. I think statements like the one on page 106 of the transcript unfortunate, and it has been called to my attention by others. I would like to read it.

Dr. Hinman states, when they discuss on page 106 that we are likely to reach 200 to 300 million gallons by 1985, far lower than what the Secretary has stated or the administration has concurred in, he is told that the figure is inconsistent. He says, "Yes, it is, because I wrote it last night." That doesn't appear very scientific.

Then Dr. Pimentel says, "That is a little bit more conservative than the other one. I think that you would make John Deutch happier with that."

That is the kind of a position that gives credence to the public's perception that this was a staged group to come up with an opinion already held by a certain group within DOE.

Mr. FITHIAN. Would you yield?

Mr. DECKARD. Certainly.

Mr. FITHIAN. That statement on 106 and the fact that the ERAB, the subcommittee, had but a 2-day meeting, isn't that correct, December 10 and 11——

Ms. HOBSON. That's correct.

Mr. FITHIAN [continuing]. To make this assessment is really just staggering, and clearly it is being shaped to what they feel the Under Secretary wanted.

Thank you for yielding.

Mr. MOFFETT. Is the gentleman finished?

Mr. DECKARD. Yes.

Mr. MOFFETT. Ms. Hobson, we have established that you are the person in charge of overseeing the Federal Advisory Committee Act. We have a situation here where a supposedly—and I emphasize the word "supposedly"—objective scientific panel actually briefs the top-level Department of Energy officials—a person, by the way, who helped put the panel together. They utilized the narrowest—and this is being kind—the narrowest interpretation of the law to exclude certain people from the meeting, not notify them about it, not keep a transcript, and not print a notice of the meeting in the Federal Register.

The Department of Energy official proceeds to use this information in an attempt to influence the Department of Energy's gasohol policy. We have pointed out some of the abuses that can occur from this kind of procedure, and you have in fact yourself volunteered that there are abuses.

What steps have you taken to see this doesn't happen again?

Ms. HOBSON. We, with cooperation from the General Counsel's Office, will be shortly submitting an option paper. Incidentally, it has been in the process for the last 4 months.

Secretary Duncan does like to get input from all of the offices involved, and I think that's a good idea. So it has been circulated for comment, an option paper with seven options. The chief option is whether or not the subgroup should come under the Federal Advisory Committee Act.

We have taken a sample of all the other Cabinet agencies. There is no other agency that uses subgroups as we do. The Defense Science Board, for instance, the Secretary or his Special Assistant appoints everyone on that Board. I think it has 152 members now, and then they compose the subgroups; but they do come under the Federal Advisory Committee Act.

We are looking for a way to deal effectively with the rapid scientific advancements and to really be agreeable and to develop a way that scientists can be effectively used and still their decisions can be in the public domain.

Mr. MOFFETT. You said that other agencies do it differently. Aren't you really saying that this is the worst agency in this area? I mean, it's hard for you to say that.

Ms. HOBSON. I am not saying it's the worst agency. I am saying that the way we do it, it can both be misused and it can be perceived as being misused.

For instance, two of the members of ERAB are also currently chairmen and Mr. Buchsbaum is formerly Chairman of the Defense Science Board. All right, if indeed we have closed meetings, then it can be perceived by the public that we are in close league with the

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Department of Defense on our R. & D. efforts. That may well be not true; but, on the other hand, if we are to gain credibility from the public with their concern about our relationships with the Defense Department as a result of the Weapons Study Group, which again appeared like it was set up to come to a conclusion already reached by the Secretary, so that therefore in order to avoid this we are trying to find a better way. The Secretary wants us to come up with some options to hear all points of view on this.

Mr. MOFFETT. Are you now getting full support for your corrective action from the Secretary?

Ms. HOBSON. Yes.

Mr. MOFFETT. Are you getting full support from the General Counsel?

Ms. HOBSON. Yes.

Mr. MOFFETT. Full support?

Ms. HOBSON. Full support. We have not gone in with our final opinion.

Mr. MOFFETT. But there's no resistance that you know of to date.

Ms. HOBSON. There is no resistance to our taking the position which we do.

Mr. MOFFETT. One of the observations that I'd like to make—and the gentleman from Indiana, Mr. Fithian, might be more familiar with this than I am—we have this wonderfully talented, massive country out there, 200 million people, with all sorts of talent and expertise. I keep looking at these lists, and we're recycling people through these advisory committees that have been on these advisory committees for years and years and years. They are refugees from the old ERDA, the Energy Research and Development Administration. Is that what it was?

[Mr. Cohen nods affirmatively.]

Mr. MOFFETT. That's just an observation. You don't have to respond to that.

I want to thank you for your cooperation with the subcommittee, with your appearance here today. I want to say on behalf of the subcommittee—I think I can say this fairly—that it's nice to see someone doing their job.

I was very critical of the Office of Consumer Affairs under Dr. Schlesinger and Dr. Schlesinger's treatment of it, his attempt in fact to kill it. So I think there's been some real improvement here, and we are grateful to you for insisting that you do your job.

Ms. HOBSON. Could I make one last statement?

Mr. MOFFETT. Yes.

Ms. HOBSON. I want to thank you for helping us keep the Office during those very difficult days when we were indeed being wiped out between Dr. Schlesinger and Secretary Duncan.

I'd also like to say because of that interest, we were able to take Secretary Duncan on a trip to Iowa and Illinois. In fact, that was on November 1 and 2, which started this whole problem, because he stated that the goal would be the same goal that the administration approved—500 million gallons by the end of 1981. He took a look at the farms and the farming community—and Bill Holmberg set up that trip for him—and came up with a higher goal for 1980 than the administration eventually settled on. So because of his involvement,

because of our concern with farmers and because of your concern with our Office, we were able to hold the line against the lower figure recommended by the draft ERAB gasohol report developed by people who really have never been out here to Indiana or to Iowa or Illinois and never talked with anyone.

Mr. MOFFETT. Well thank you, very much.

Thank you, Mr. Cohen.

[Ms. Hobson's prepared statement follows:]

STATEMENT BY TINA HOBSON, DIRECTOR, OFFICE OF CONSUMER AFFAIRS, DEPARTMENT OF ENERGY

Mr. Chairman and members of the Subcommittee, thank you for the opportunity to appear before you today in connection with your examination of possible violations of the Federal Advisory Committee Act which may have occurred in relation to a recent Energy Research Advisory Board report on gasohol.

I am going to repeat the testimony I gave during the question and answer session at the June 25, 1980, hearing before the Subcommittee on Energy of the Joint Economic Committee.

I am Director of the Office of Consumer Affairs and have been designated as the Advisory Committee Management Officer for the agency and therefore have a responsibility for implementation of the Federal Advisory Committee Act (FACA).

DOE is in the process of resolving several key policy issues relating to advisory committee management. One of the issues concerns the extent to which all subgroups of DOE advisory committees should be subject to FACA.

In accordance with a DOE General Counsel opinion of December 4, 1978, subgroups of advisory committees may have members who are not on the parent committee. These subgroups are not subject to the Federal Advisory Committee Act as long as they provide advice

or recommendations only to their parent committee and not directly to a Federal agency or official. Although unchartered subgroups are legal in terms of our General Counsel opinion, they may be misused.

The Gasohol Study Group of the Energy Research Advisory Board was established in November 1979. Membership consisted of:

Dr. David Pimentel, Cornell University (Chairman)
Dr. Charles Cooney, Massachusetts Institute of Technology
Dr. Richard L. Hinman, Pfizer, Inc.
Dr. William Scheller, University of Nebraska
Dr. Thomas E. Stelson, Georgia Institute of Technology
Dr. Jack M. Spurlock, Georgia Institute of Technology
Dr. Paul Weisz, Mobil Research and Development Corp.
Dr. James Vance, Consultant

Messrs. Pimentel and Stelson were members of the parent ERAB.

The only meeting of the Gasohol Study Group, of which I am aware, was held December 10-11, 1979. Notice of the meeting was not published in the Federal Register.

I learned of the Gasohol Study Group meeting on December 10 after it was already in session. There were no plans for public participation or the making of a verbatim transcript. Although public participation and making of verbatim transcripts may not have been legally required, I believed that the issue of alcohol fuels was

very significant and of great public concern. Therefore I personally took a court reporter to the meeting on the second day and had a transcript made.

On December 19, I met with Ed Frieman, Director of Energy Research, his Director, Office of Advisory and Liaison Programs, Bill Bartley, and Sol Buchsbaum, Chairman of the Energy Research Advisory Board. We reached an agreement on some procedures related to subgroups of ERAB. Part of our agreement was assurance by Dr. Buchsbaum that reports would be submitted in preliminary draft form to ERAB for approval before they are submitted to DOE. This would insure review by a balanced committee that includes three consumer members, including Amory Lovins.

On December 19, 1979, John Deutch forwarded a draft of a memo to the Secretary dated December 17, 1979, to several DOE officials for comment. The draft memo contained recommendations for the DOE Gasohol Strategy which Dr. Deutch stated was based on "...most importantly,... the results of a Committee of the Energy Research Advisory Board..."

I called Dr. Buchsbaum and pointed out that in spite of our verbal agreement, the Gasohol Report would apparently have an impact in DOE before it was approved by the full ERAB.

I also wrote a memorandum to John Deutch on December 20 calling attention to the implication in his draft memo of December 17 that the results of the Gasohol Study Group were approved by the full Board.

At the May 1 and 2 meeting of ERAB, the Gasohol Study Report was on the agenda. Amory Lovins, a member of ERAB, advised me on April 29 and 30 that he was not notified of the May 1 and 2 meeting. Amory Lovins has since indicated that all his back mail has been received and there was no notice of the May 1-2 meeting.

I took one of the people Mr. Lovins recommended as his alternate, Ken Bossong, of the Citizen's Energy Project, to the meeting. However, Dr. Buchsbaum would not allow Mr. Bossong to serve as an alternate although Richard Alban had been listed as an alternate to Roland Schmitt, General Electric, at the February 8, 1980, meeting. I want to add that Dr. Buchsbaum contends that Mr. Alban was in fact present not as an alternate but as a resource person on a specific report because of his participation in its preparation. Mr. Lovins has since sent a letter to the Secretary indicating his disagreement with many of the findings in the Gasohol Report.

In order to accommodate the special need to obtain advice directly on short-term programs or when time is of the essence, to allow increased public participation, and still comply with the Federal Advisory Committee Act, my office suggested and our General Counsel formally recommended to OMB that short-term committees (less than one year) be exempted from the requirement that they be chartered, but continue to require that they comply with all other provisions of FACA and implementing regulations.

This concludes my testimony and I will be glad to answer any questions.

Mr. MOFFETT. Our next witnesses are Mr. Bert Greenglass, the Acting Director of the Department of Energy Alcohol Fuels Office, accompanied by William Holmberg of that same Office.

Gentlemen, you know that it is the practice of the subcommittee to swear in all witnesses. Please raise your right hand.

Do you swear to tell the whole truth and nothing but the truth, so help you God?

[Chorus of "I do."]

Mr. MOFFETT. Thank you. Thank you for being with us, and for coming out here for the hearing. As you perhaps heard me say to the previous witness, without objection we will consider your statement as a part of the record and you may proceed in any way that you wish. You may paraphrase the statement, if you wish.

STATEMENT OF BERT GREENGLASS, ACTING DIRECTOR, DOE ALCOHOL FUELS OFFICE; ACCOMPANIED BY WILLIAM HOLMBERG, DIRECTOR OF MARKETING SUPPORT

Mr. GREENGLASS. Mr. Chairman and members of the committee, I thank you for this opportunity to discuss the Department's response to the April 29, 1980, report of the Gasohol Study Group of the Energy Research Advisory Board on gasohol.

Mr. Chairman, if I may before I get started, I would like to again introduce Mr. Holmberg who is currently the Director of Marketing Support for the Office. I'd also like to point out that he is the leading director—individual—in the development of our reply to the ERAB study and is here for that reason.

Before I get into the euphony of words that may make some of the points that we want to make, I'd like to really state at the outset that the Department of Energy and Secretary Duncan are foursquare behind the alcohol fuels program. I'd also like to point out that the ERAB study has not had a negative influence upon the financial industry itself.

I'd also like to point out that the ERAB study was unusually conservative when addressing ethanol production and was unusually optimistic when addressing methanol. In fact, the program as the Department has now established it does address ethanol very optimistically, very positively, through the duration of 1980 through 1985, at which time we anticipate bringing on a form of cellulosic conversion which would thereby bring about ethanol from cellulose and supplement the production of ethanol from grain. And then by 1990, we hope to bring in methanol production from coal, giving us continuity and heading us toward the complete goals of the Department and the administration for the production of alcohol.

Following the release of the ERAB gasohol report, the Secretary of Energy directed the Office of Alcohol Fuels to review and respond in detail to the ERAB report's recommendations and report back to him. We have completed our technical review of the ERAB report, and we expect to forward our position on it to the Secretary in the immediate future.

The Office began its review of the ERAB gasohol report virtually the day we received it. Our review has been a detailed and technical one and includes information provided by the Solar Energy Research

Institute, the National Alcohol Fuels Commission, the Idaho National Energy Laboratory, the National Alcohol Fuels Producers Association, and many, many members of the young industry, as well as the scientific and technical communities. Some of the country's most knowledgeable people in the field of alcohol fuels production, including many with a pragmatic hands-on alcohol production experience, reviewed our original draft report and submitted their own comments and criticisms. These comments and criticisms are included in our latest product. Thus, the final response before you today represents a current thought and experience of fuel alcohol pioneers on the frontier of this developing new industry as well as the Office of Alcohol Fuels.

I would like to summarize some of our preliminary findings today. They are:

The Nation can and will meet the administration's ethanol production capacity goals, as well as those set by Congress in the Energy Security Act of 1980. The Gasohol Study Group estimates for 1985 ethanol production, which did not predict later significant administration and congressional alcohol fuels initiatives, are thus out of date. We may, in fact, exceed ERAB estimates by as much as tenfold in 1981 and 1985.

Production of ethanol from biomass is commercially available and in widespread operation throughout the country today. The growing alcohol fuel industry is already reducing our dependence on imported oil through increasing domestic ethanol production.

Three: Many technological and energy-saving advances in ethanol production processes are occurring at an accelerating pace. Ethanol producers in many parts of the country are realizing substantial energy gains now and expect even greater efficiencies in the near term. With these advances, the net energy balance of alcohol fuel production will continue to improve. It is already positive and getting better.

Four: Administration and congressional ethanol production and capacity goals can be met without an adverse effect on food supplies or prices. There are significant opportunities to use agricultural and food processing waste products and to develop high-yield energy crops for substantial production of ethanol, thereby reducing cost to the consumer. Further, the ethanol-from-grain process produces valuable, protein-rich coproducts which are suitable for export and domestic use.

Farm-scale ethanol production can strengthen the family farm by generating a steady cash flow to farmers while providing an uninterruptible supply of high-grade liquid fuel to power farm machinery.

It must be remembered that the ERAB gasohol report was undertaken on a quick turnaround basis, according to ERAB Chairman Dr. Solomon Buchsbaum. The Gasohol Study Group met for 2 days, on December 10 and 11, 1979; and at that time, by all accounts, the group agreed upon a number of findings and recommendations. They issued a draft report 2 days later, on December 13, 1979. Now while the group submitted its final gasohol report to the ERAB Chairman on April 29, 1980, the study was conducted, in fact, in December 1979.

The following events, which have had substantial impact on alcohol fuels development, occurred during the first 4 months of 1980 after the study was conducted but before the final ERAB report was submitted to the Secretary:

One: On January 11, 1980, the President announced a comprehensive national alcohol fuels program to accelerate domestic production of alcohol fuels from nonpetroleum sources. The program seeks to quadruple January 1980 alcohol production capacity by the end of 1980 and sets a target for domestic production capability of 500 million gallons during 1981. As I said earlier, we anticipate achieving the 1981 goal.

Two: On February 14, 1980, the Office of Alcohol Fuels was created within the Department to promote ethanol production from biomass and to implement the DOE alcohol fuels program.

Three: On April 2, 1980, the Crude Oil Windfall Profit Tax Act of 1980 was signed into law by the President. Among other incentives, the act continued the 4-cent-per-gallon Federal excise tax exemption for gasohol for 8 more years—that's from 1984 through 1992. It provided new income tax credits for alcohol-gasoline blenders and extended through 1985 tax credits for alcohol fuel production equipment. This act in itself obviated in large part the estimates and assumptions of the ERAB study.

Four: The Energy Security Act of 1980, containing additional financial incentives to stimulate alcohol fuels from biomass production, was advancing through Congress with increasing assurance of passage. As you know, it was signed into law on June 30.

Five: Demand for gasohol at the pump has steadily increased, with the number of service stations throughout the country offering gasohol to motorist, nearly doubling. Today, there are over 5,000 stations selling gasohol in this country, and the demand continues to rise.

I do not think it is necessary to explain to this committee the significance of these congressional and administration initiatives. Members of this committee were instrumental in moving the Crude Oil Windfall Profit Tax Act and the Energy Security Act through the Congress. The Department and the Office of Alcohol Fuels would like to thank the committee members for the support. Likewise, the Secretary recently testified before the National Alcohol Fuels Commission on the Department's strong commitment to increased production and use of alcohol fuels, when he stated:

> The Department of Energy is committed to two objectives in this area: to achieve the President's alcohol fuels production target and to implement aggressively the mandates of Congress. This effort is already underway.

The Secretary has provided the Office of Alcohol Fuels with complete and full support to achieve these goals.

It should suffice to say the conditions affecting domestic alcohol fuels development changed dramatically in the first 4 months of 1980. These changes, as evidenced in the events described above, and their likely impact on the development and production capacity of the growing alcohol fuels industry, were not considered by the Gasohol Study Group, nor were they factors of the findings and recommendations contained in the report. The final ERAB report was significantly out of date at the time of its release as a result of the previously mentioned far-reaching congressional and administration alcohol fuels initiatives which occurred in the intervening period between December and April.

Nevertheless, it is essential that we address the hard issues presented by the challenge of developing a new industry such as alcohol

fuels. Some of these issues are technical in nature, and our response attempts to address the two most prominent issues raised in the ERAB report: The question of food versus fuel and the net energy balance of ethanol production.

The Secretary of Agriculture recently testified before the National Alcohol Fuels Commission and stated:

> Distillation capacity, not agricultural feedstocks, is currently the restraining factor on fuel alcohol production. At the present time, adequate supplies of corn and other fermentable commodities are available from the market at competitive prices.

Cyclical weather patterns, of course, will affect the availability and price of agricultural feedstocks, but the Secretary further stated, "As matters now stand, we don't think the food versus fuel issue is a serious question because a modern recovery system can convert starch and leave protein." He then added that he did not anticipate any food shortages as far as our country is concerned.

The Office of Alcohol Fuels is currently exploring the vast potential of ethanol production from agricultural and food processing waste products, high-yield energy crops, and new technologies in cellulosic conversion. Developments of these fronts offer the possibility of substantial ethanol production capacity without significant impact on food supplies by the mid-1980's. In fact, there is no question that we can achieve the administration's goals for 1985 without in any way affecting food production or food availability or food prices. It must also be remembered that, when grains or other edible feedstocks are used in the ethanol production process, a portion of the feedstock is converted to valuable protein-rich coproducts, such as corn gluten meal or distiller's dried grain, which are suitable for export and domestic use.

When the food versus fuel issue is raised, it is often implied that were corn or other feedstocks not used for alcohol production, they would go toward feeding the world's poor. However, 90 percent of the whole corn sold in this country goes to cattle feed. Most exported corn goes to developed countries, where it is used for animal feed. Thus, for the most part, this grain is not used to feed the world's poor in underdeveloped countries. Yet this animal feed market could be further developed by exporting protein-rich distiller's grain or wet and dry milling concentrates that can be combined with local carbohydrates and forage crops to balance the feed rations.

The net energy balance issue was also raised in the ERAB gasohol report, which concluded that, utilizing the best available technology before 1985, the net energy balance is about zero for ethanol produced from corn and other crops in fermentation/distillation plants. If the fermentation/distillation plants are fueled, it says, by coal or wood, each gallon of ethanol produced could save roughly 0.5 gallons of oil. ERAB used very conservative assumptions in arriving at this conclusion. For example, they assumed that the mechanical equivalent of ethanol to gasoline was less than equal, while in fact, in the very report they submitted, they showed in parentheses energy balances which were based on mechanical equivalency. Mechanical equivalency, I would like to point out, means the miles per gallon that can be achieved by a vehicle if it's driven on gasohol versus regular gasoline.

It is generally accepted now that, due to the other factors of alcohol and gasoline, the mechanical equivalency should be at least equal. Therefore, even in that report, in parentheses, they provided a positive energy balance parenthetically included and noted in their detailed notes.

There are two points which must be kept in mind in any discussion of net energy balance for alcohol fuels production. First, technological and energy-saving advances in production processes are occurring at an accelerating pace, resulting in substantial energy gains now and even greater energy efficiencies in the near term. With these advances, the net energy balance of alcohol fuel production will continue to improve.

I have been advised that here at Purdue they have in fact had some recent apparent breakthroughs which would increase the energy efficiency of ethanol production. We are hoping to see some of that later today.

Second, energy balance is a nonissue to the extent that domestic ethanol production, utilizing nonpetroleum sources, reduces our dependence on imported oil, thus contributing to our balance of payments and national security.

At a recent hearing on gasohol allocation before the Economic Regulatory Administration, one major oil company estimated that for every barrel of ethanol used as a gasoline blending component, gasoline yields could be increased by as much as two barrels, 2 to 1.

The U.S. General Accounting Office, in a June 3, 1980, report on potential of ethanol as a motor vehicle fuel, addressed the net energy issue and stated, as follows:

> Our work in the area has shown that net energy analysis is not an exact science—that is an understatement—therefore, any two or more studies of a particular energy system can yield vastly differing results, depending on the methodologies, approaches, and systems boundaries selected. There is also a tendency to overemphasize net energy aspects of ethanol as a fuel, thereby losing sight of the real objective: producing usable liquid fuels. For example, using coal to fire the distilleries to process grain and other crops into ethanol may, as some studies show, result in a net energy loss. But the process produces a fuel which is more readily adaptable for certain uses, for example, motor vehicle fuel.

I support this position completely, and I would go even further.

In conclusion, the national alcohol fuels program will achieve the production capacity goals announced by the President as well as those set by Congress in the Energy Security Act of 1980. These goals can be met without an adverse effect on food supplies or prices. Domestic ethanol production is already reducing our dependence on imported oil. With technological and energy-saving advances now coming on line, we are beginning to realize substantial energy gains, and the net energy balance of alcohol fuels production will continue to improve.

There is much work ahead to achieve these goals. Constraints and barriers to alcohol fuel production and marketing must be identified. Regulatory requirements must be streamlined to bring additional ethanol production capacity on line as soon as possible, and research and development must be directed toward the numerous opportunities to make ethanol production processes even more energy efficient.

The ERAB report is behind us. At this time, we must move ahead to develop and promote the fledgling alcohol fuels industry and to meet

the ambitious but achievable goals for alcohol production that the President and you, the Congress, have set.

Mr. Chairman, this concludes my prepared testimony, and I would be pleased to answer any questions you may have.

Mr. MOFFETT. Thank you very much, Mr. Greenglass.

At this time, the Chair will recognize members for questioning under the 5-minute rule. The Chair now recognizes the gentleman from Indiana, Mr. Fithian, for 5 minutes.

Mr. FITHIAN. Thank you, Mr. Chairman.

Thank you for your testimony. I must say, Mr. Greenglass, that this testimony and this statement this morning is about 180 degrees apart from the ERAB report of December. I commend you all for taking a more careful look at it.

As I understand the overall essence from your testimony and others, the goals and the achievable production goals that various people and various studies report, it goes something like this: The President has announced the goal of 500 millions gallons per year by the end of 1981. Is that correct?

Mr. GREENGLASS. Production capacity, that's right.

Mr. FITHIAN. And the Department of Energy's report back in June 1979 set 500 million gallons per year by 1985.

Mr. GREENGLASS. That's right.

Mr. FITHIAN. So according to that older report, it would take an additional 4 years to arrive at that production level.

Mr. GREENGLASS. That's correct.

Mr. FITHIAN. Then a year later in your July 1980 estimate, you have upped that to 2 to 3 billion gallons per year by 1985. Is that correct?

Mr. GREENGLASS. It's 2 billion, yes.

Mr. FITHIAN. Two billion?

Mr. GREENGLASS. Yes.

Mr. FITHIAN. In 1 year you have increased your estimate by 400 percent in terms of the productive capacities achievable.

Mr. GREENGLASS. It would appear that way, yes.

Mr. FITHIAN. Just for the record, Mr. Chairman, I would point out that the Office of Technology Assistance in their report, in October 1979, estimated a range of 1.3 billion to 2.6 billion gallons by the end of 1980. So, that is pretty much in keeping with what you now believe. Is that correct?

Mr. GREENGLASS. That's true, yes.

Mr. FITHIAN. And finally, the GAO report projects it on out in their assessment to 11 billion gallons a year by the year 2000. I think that the optimism of those of us who believe this is a viable alternative is now more and more being corroborated by what you are saying and what these other reports are saying, and it was for that reason that the ERAB report seemed so much like the private who was the only one in line that was out of step. The fact that it was fashioned in 2 days, I really wonder at that process. You know, we have scientists in the field working for years and we pull together a handful of people and they whip out a report upon which you in the sector are supposed to make policy; and they do this in 2 days. I really wonder, Mr. Chairman, whether we should fund such activities at all. That's my own editorial opinion.

Let me turn to one other comment on your testimony, on page 2. You say that, for example, one company may produce the ERAB study group's 1985 production estimate by the end of 1981. I presume you are referring to Archer, Daniel Midland.

Mr. GREENGLASS. That is possible; yes.

Mr. FITHIAN. I visited that company in January and looked at their facilities. They are building, 24 hours a day, expansion; and they told me at that time, in January, that they expected themselves to be able to go to 400 to 500 million gallons per year at the end of this year, 1981. If that's the case, then clearly they are going to exceed everything that the ERAB people thought was achievable by 1985.

My question is, with all of the information that was around—this just didn't generate since December—some of the findings of ERAB contradict data that's as old as 1937. So, I appreciate your testimony and appreciate your thrust here, but one part of it that I have a little trouble accepting is the notion that the error crept in because of the lack of advance between December and April. I think the error was built in, in some fashion or another, simply because of all of the other evidence. Certainly the President didn't grab that figure out of the air in January, nor did you grab the figure out of the air 4 months earlier.

Well, I have a couple of questions, specific questions to your testimony. One is on page 6, and this is really my central concern. In January, after the discussion of the possibilities of policy, I asked this question and I would ask you the same question this morning. I said: But is everybody on board? Are all policymakers pointed in the same direction?

You say that the Department of Energy is committed to two objectives on page 6, in this area: To achieve the President's alcohol fuels production target and to implement aggressively the mandates of Congress. This effort is already underway. I realize your enthusiasm and I realize your position you are moving into, but again I have to as the question, whether or not all policymakers are pointed in the same direction.

It has been my sad experience over the past 4 years to discover that rarely were two policymakers pointed in the same direction.

Mr. GREENGLASS. I think that at the Department of Energy at this point in time, the fact is accepted that alcohol fuel is here and that ethanol production is going to proceed at a rate far greater than previously anticipated.

Mr. FITHIAN. What are your chief obstacles in the Department, to actually getting an across-the-board commitment to us or who are your chief obstacles?

Mr. GREENGLASS. I think at this time I would have to say that the obstacles are coming down. Every agency has its form of bureaucracy which takes a little time to turn around and go with the trend. I would have to say that the bureaucracy at the moment is the only barrier. Taking time to let the office get established and to achieve its programs; and getting the funds we need, not only for the financial incentive that the Congress has provided us funds for, but funds to operate with and to perform the research and the work necessary to overcome constraints and barriers to the producers.

Mr. FITHIAN. Mr. Holmberg, you have been in at least a couple of different pressure points in the Department in the pursuit of alcohol

fuels. I would ask you the same question. What are the chief obstacles? What have been the chief obstacles in the last 18 months or 2 years and what are the chief obstacles now, for I get reports from several people at working levels around, throughout the Department, that all is not yet well, believe me?

Mr. HOLMBERG. Mr. Congressman, I think the chief obstacle, as Bert Greenglass pointed out, is the bureaucracy itself. It's got a momentum; it's got a mind set that moves at a given pace. We are trying to deal with that. If we don't deal with it gently and skillfully, in spite of the fact that we have full support from the Congress of the United States, the bureaucracy has a way of simply delaying things.

Mr. FITHIAN. Well, let me ask you as longtime experienced people, in 4 or 5 years of dealing with this it is my perception—and I could be wrong, Mr. Chairman—but it is my perception that the Department has been certainly under Mr. Schlesinger, and less so now, essentially dominated by two kinds of people: those people who have a nuclear background and are pointed in that direction and believe sincerely that the solution to America's energy policy is in the expansion of nuclear power, and those who have a background of experience in petroleum. Those of you who are in alcohol fuels are really new kids on the block. Even the old technology of coal is the orphan child of the energy family.

Now, Mr. Moffett is on another energy and power subcommittee and perhaps his view is like mine or different from mine on that, but it still seems to me that despite your enthusiasm, Mr. Potts' obvious enthusiasm before you, that when it comes to real clout in the Energy Department, when the push comes to shove for the mind of the Secretary, it still is nuclear and petroleum. Now, am I right or wrong?

Mr. GREENGLASS. I don't think I am really in a position to say whether it is or not. I can say that the Secretary pays a great deal of attention to our needs. Whether our needs are always properly communicated to him as quickly as they should be may be a problem.

Mr. MOFFETT. Would the gentleman yield?

Mr. FITHIAN. I would be happy to yield.

Mr. MOFFETT. I think the gentleman raises a very important point here. Mr. Greenglass, when you say your views are always communicated to him, it sounds like you are a parish priest trying to get something to the Pope in Rome. Do you talk to him?

Mr. GREENGLASS. Yes; I do.

Mr. MOFFETT. Do you report directly to him?

Mr. GREENGLASS. Yes; I do. I do report directly to him, but the daily routine matters of budget, of acquiring space, and of acquiring people are handled through the bureaucracy.

Mr. MOFFETT. Well, if the gentleman will yield further just for a moment, what does it mean when you say, in response to my question, that you report directly to him? I thought you reported to Mr. Stelson.

Mr. GREENGLASS. Organizationally at this time, I report to the Assistant Secretary through the Deputy Assistant Secretary, and so on.

Mr. MOFFETT. So you report to the Deputy Assistant Secretary who reports to the Assistant Secretary——

Mr. GREENGLASS. That's right.

Mr. MOFFETT [continuing]. Who is on this Gasohol Study Group, by the way——

Mr. GREENGLASS. Yes; he was.

Mr. MOFFETT [continuing]. Who then reports to the Secretary presumably?

Mr. GREENGLASS. Yes. In fact then he too, though, reports through the Under Secretary.

Mr. MOFFETT. Through the Under Secretary to the Secretary?

Mr. GREENGLASS. That's correct.

Mr. MOFFETT. All right, now that that's established, what is the nature of your relationship, this direct relationship that you have just told us about, with the Secretary? How does that manifest itself?

Mr. GREENGLASS. I intended to really qualify it, to point out that personally I can discuss the matters with the Secretary, and I do deal on a daily basis with his immediate staff. Organizationally, I do, as just noted, report through a structure that is far more complex and that was the point to which that I referred.

Mr. FITHIAN. Well, let me interrupt. It isn't just that it is complex. That is the nature of the beast; that is the nature of the bureaucracy.

Mr. GREENGLASS. Yes; it is.

Mr. FITHIAN. What is bothering some of us is that you must, on a practical matter, funnel it through—your input to the Secretary—through a person who sat on a panel that devised and agreed to a report that is patently false. It is very negative to alcohol fuels, and it is clearly an effort to sidetrack gasohol as a national issue.

In the Office of Alcohol Fuels, as I understand the flow chart, you are sitting there reporting through someone who is very negative on alcohol fuels. Before Mr. Deutch's departure, he then—that is the second echelon—had to report to Deutch who was even more opposed to alcohol fuel. By the time it got to Schlesinger, it's a wonder that we ever had any support for alcohol fuel. I think with Charlie Duncan's best intentions, we still have some of the same fundamental structural problems and we still have to go through some very negative individuals.

I want to take just one more question, Mr. Chairman, and then I will subside.

On page 11, you say what I wish were true; and, that is, that the ERAB report is behind us and at this time we must move ahead to develop and promote the fledgling alcohol fuels industry, et cetera. I'd have to ask you whether or not the impact of the ERAB report is truly behind us. As I understand it, this is as yet the official ingredient of the Department's policy and programs and for people out in the hinterland who, for example, go into local banks and try to borrow money or get fronting for this, this is a new technology and the bankers do not know whether somebody is being sold the Brooklyn Bridge. They turn to the Department of Energy, and the official document of the Department of Energy says no future for alcohol fuels. What does that do to the credit rating of the person who wants to set up an alcohol fuels plant for a co-op out here?

Mr. GREENGLASS. It unquestionably has had an impact.

Mr. FITHIAN. An adverse impact, is that what you are saying?

Mr. GREENGLASS. In the hinterland, yes; not within the Department. It is not Department policy; it is not part of this policy; we have not

used it to date; but it has had an effect in the hinterland and there's no question about it.

Mr. FITHIAN. In your report, what you presented to the chairman and to the committee, will this then be what should be looked to in the next 6 months and the next year as the real policy of your Department?

Mr. GREENGLASS. Absolutely, and it is at this moment the policy of the Department.

Mr. FITHIAN. Thank you, Mr. Chairman.

Mr. HOLMBERG. Mr. Chairman, can I respond to Congressman Fithian's earlier question about the nuclear people and the coal people?

Mr. MOFFETT. Yes; certainly.

Mr. HOLMBERG. I think the real issue is that at the Washington level, at the policy level, you are looking for clout and you have to look to those big levers, those big mechanisms, to give you that level of energy. It's hard for people at that level to perceive that out in the communities we can deliver the Btu's, and each community working together in solar, renewable and conservation delivering those Btu's through a variety of instruments will give you the clout back in Washington. So I think it's sort of biased, in terms of a national policy-setting organization where they just see big levers out there and it's hard for them to perceive a little leverage out in the community.

Mr. MOFFETT. Well, I think that's one of the central things that we are getting at in this hearing and, as a matter of fact, in many, many other things that this subcommittee does. We have done a great deal of work, more than any subcommittee in Congress, on conservation, as I think you know, and tried to point out that in the initial phases—and I think this is what you are saying—reaching for at least a balance between a highly centralized capital-intensive energy policy and the decentralized less capital-intensive but equally productive and fruitful policy is a difficult political chore. There's just no question.

I think what Mr. Fithian was saying is, when you look at political power—I am not talking partisan political power—political power, there is more political power behind a highly centralized capital-intensive technology in the form of political action committee contributions to candidates, from nuclear industry and this industry and that industry and so forth, but the people, if we have our way, who constitute the core of the gasohol industry are not in that kind of position. Let's face it. They are not organized in that particular fashion; so, that's part of it. It's a combination of that.

Mr. HOLMBERG. But if you look at the people political power coming into the game now, which is a brand new opportunity——

Mr. MOFFETT. That's right.

Mr. HOLMBERG [continuing]. In terms of trying to release the creativity and ingenuity and determination of the people who involve themselves in something as important as the Nation's energy policy, it's a new game.

Mr. MOFFETT. Well, we agree with that and it's music to our ears to hear someone from DOE say it.

Mr. GREENGLASS. Mr. Chairman, I wonder if I could add something. There is one piece of information that I did not include in my answer to

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Mr. Fithian, and that is that the Energy Security Act, as recently legislated, does provide for the Office of Alcohol Fuels to report directly to the Secretary, and I am currently engaged in the final negotiations to bring that about. We regret that it has taken so long, though.

Mr. MOFFETT. What is there to negotiate? We said, and I was a member of that House-Senate conference committee, that your office will report directly to the Secretary. Now, we don't need a study or anything, do we, to see how that happens?

Mr. GREENGLASS. You are completely correct. It has just taken a little time to work out the details.

Mr. MOFFETT. Is there resistance to that?

Mr. GREENGLASS. At this time, no, there is not.

Mr. MOFFETT. Your testimony, under oath, is that there is no resistance to that.

Mr. GREENGLASS. Not to my knowledge, no.

Mr. MOFFETT. So your organization will be reporting directly to the Secretary, as far as that is your expectation.

Mr. GREENGLASS. That is my expectation.

Mr. MOFFETT. Not through anyone else.

Mr. GREENGLASS. My expectation is that we will report to the Secretary.

Mr. HOLMBERG. That's a question that needs to be asked again sometime.

Mr. MOFFETT. Marvelous candor from these witnesses today.

The gentleman from Indiana, Mr. Deckard. Since we did have Mr. Fithian go on for about 10 minutes, the gentleman is free to take at least that much time.

Mr. DECKARD. Well, thank you, Mr. Chairman. I doubt that I will require that much time.

Mr. Greenglass, early in your statement you said the report had not had a negative impact on the program, and I wonder why it did not. Was it so obviously biased that it wasn't taken seriously from the very beginning?

Mr. GREENGLASS. Within the Office of Alcohol Fuels, that is true. We really received it as completely biased at the time and reserved our right to make judgment until after we conducted a study.

Mr. DECKARD. Who was the Assistant Secretary that was a member of that group?

Mr. GREENGLASS. Assistant Secretary Stelson.

Mr. DECKARD. Is he still Assistant Secretary? Is that correct?

Mr. GREENGLASS. Yes; he is.

Mr. DECKARD. And you are still reporting, well, to the Deputy Assistant Secretary who reports to Mr. Stelson who reports to Mr. Duncan.

Mr. GREENGLASS. At this time.

Mr. DECKARD. Does that cause you any concern that perhaps your story is not getting through to the Secretary of Energy?

Mr. GREENGLASS. I would say that it has to harm our ability to communicate, yes; but I must say that it is not my only course. As I mentioned earlier, I can approach the Secretary; we do meet and we do discuss matters at this time.

Mr. DECKARD. I don't expect you to comment on the competence of someone who in the hierarchy is somewhat above you, but I think

anyone who looks at this report and the conclusion that the report draws, after 2 days of ostensible deliberations, gets a good indication of why the Department of Energy has received as much criticism as it has from across the whole spectrum of political thought in Congress. I won't ask you to respond to that observation.

There obviously had to have been some contact between the members of that group prior to December 10 or 11. You don't arrive at a major report in a 2-day period of time. We discussed earlier the legalities or illegalities of the methods in which that group operated, but is that standard procedure, that decisions are made prior to the actual convening of a deliberative group within the Department of Energy?

Mr. GREENGLASS. I am really not in a position to make that statement. I think I would have to refer that back to Tina Hobson. I am not aware of its practice.

Mr. DECKARD. Well, I wonder if Ms. Hobson was listening and could perhaps respond.

Ms. HOBSON. I am not aware of whether there's any other study group. I know the Weapons Lab Study Group studied it over a period of time. The fusion report that just came out was a matter of five meetings. Incidentally, that went directly to the agency, again, rather than through the full committee. I know of no other group that has looked at something as significant as this that has taken so short a time. My answer would have to be that.

Mr. DECKARD. I might comment on the weapons group you mentioned several times this morning. Although I am not aware of its specific mission, its name suggests that its mission is such that perhaps secrecy might be something that would be appropriate in that case.

Thank you, Ms. Hobson. I appreciate your information.

Ms. HOBSON. But that's all right. I mean, that is provided under the Federal Advisory Committee Act. It's only where secrecy is not appropriate that we are discussing it.

Mr. DECKARD. I wonder, Mr. Greenglass, has there been any consideration to updating this report to make it more accurate, to take into consideration all of those factors that have occurred since the December meeting?

Mr. GREENGLASS. No, not at this time.

We are, however, going to publicly issue the Office of Alcohol Fuels' analysis of that report, which we think will set the record straight and establish for the country a more accurate position on alcohol fuels.

Mr. DECKARD. There has been a great deal of criticism made of the Department of Energy, its widespread use of advisory groups and consultants, and the major portion of DOE's budget that goes toward those costs. Who are the people who make the decisions as to who sits on these groups? We have touched on that earlier this morning, about the ERDA people and the musical chairs that take place. Is there any concentrated effort within the Department of Energy to seek out the expertise that's available all across the country and, for that matter, right here in Lafayette at Purdue University and some other fine universities in the State of Indiana, just to use one example? There are people who are eminently qualified to sit on these kinds of groups. Is there any effort made to find these people?

Mr. GREENGLASS. Again, I am really not qualified to address the the process of these committees. I would have to again accede to Tina relative to the question of whether there are other ways of improving the process for membership, for selecting the membership on those committees.

Ms. HOBSON. There are two ways. One is to do like the Defense Science Board, which is to have the Secretary or the Special Assistant choose all members and then pull them out in the subgroups and then disband them when the subgroup is no longer necessary. That is one acceptable way currently under the Advisory Committee Act.

A better way which we think right now—and we will give you more information—is to revise the Advisory Committee Act so any group that meets less than a year need not be chartered, because that takes 6 months to charter a group; but that, rather, it can exist as long as it meets the other criteria of the act, which is open meetings, unless it's an issue of national security. The weapons lab did not state it was national security, that subgroup. They said they were not responsible to the act, which is entirely different.

Mr. DECKARD. When are those recommendations coming out?

Ms. HOBSON. They have gone to OMB. It's the last paragraph in my testimony, and we feel that that's a much more acceptable way of dealing with the real problem.

Mr. DECKARD. Thank you very much.

Mr. HOLMBERG. Could I respond to that, sir?

Mr. DECKARD. Certainly.

Mr. HOLMBERG. Looking at the competency of the Gasohol Study Group or the involvement in terms of stretching or violating some of the rules, it's sort of interesting, but it doesn't get us to the real point on that. I think that the real point in terms of the gasohol effort was that they relied on existing published data. They did not go to the field; they did not go to the barns and the backyards and the basements of the people of this country to see what was going on, and I think that's also applicable in the other renewable energy areas. We have got to go to the countryside to see what people are doing and reflect that in national policy and not only rely on published scientific data.

Mr. DECKARD. That's essentially a corollary of what I had said a moment ago. There doesn't appear to be any effort to reach out to the Purdues and the IU's and the other universities around the country to provide just as much expertise, if not better than what we find in the Washington circuit, which so many times is loaded with conflicts of interest, which are apparent from this report.

Thank you, Mr. Chairman.

Mr. MOFFETT. I have a few questions for you gentlemen.

Let's make sure that the record is accurate on what happened here. This study group put their report together in December 1979. Isn't that correct, Mr. Greenglass?

Mr. GREENGLASS. [Affirmative nod.]

Mr. MOFFETT. And the full board, advisory board, approved the report in May 1980?

Ms. HOBSON. Amory Lovins did not approve it.

Mr. MOFFETT. Not the full board. It was not unanimous.

So let's just focus on the period between December 1979 and May 1980. We know that in the intervening time between December 1979 and May 1980, a couple of things happened. One, the Congress passed a windfall profits tax. Two, there was the creation of the Alcohol Fuels Office at the Department of Energy. Three, as I think you have noted, this synthetic fuels bill was moving along. We also know that when this report was approved in May 1980, it really didn't take into account a lot of the things that had happened, as you have noted during this intervening time. In fact, it was outdated information in many respects. Is that correct?

Mr. GREENGLASS. That is my opinion, yes.

Mr. MOFFETT. Why was not information on these interim events and happenings included when the board came together? Did they come together in May 1980?

Mr. GREENGLASS. I believe they came together in April.

Mr. MOFFETT. They physically came together and met.

Mr. HOLMBERG. They came together in February and in May, but not as a study group.

Mr. MOFFETT. Fine. Why didn't they say, OK, we are going to reconsider or we have new information here or we have to adjust certain things?

Mr. GREENGLASS. I don't have an answer for that. I must say that, if I were in their position, I would have at that time made corrections, if I were there.

Mr. MOFFETT. Was there pressure from anyone in DOE, that you are aware of, just to get the show on the road and get this thing approved?

Mr. GREENGLASS. Not at that point in time. Are you aware of anything, Bill?

Mr. HOLMBERG. I don't think there was pressure within DOE, but clearly they had already established their position, and clearly that position had been considered. It would be after the fact to go back and mend some of the fences that were torn down during that troublesome period between Christmas and New Year's.

Mr. MOFFETT. And yet there was controversy by this time, by May 1980, about the report. Isn't that correct?

Mr. HOLMBERG. Yes.

Mr. MOFFETT. So, in a way, they were stonewalling it with their report, saying we are going to get this thing through?

Mr. HOLMBERG. There is also the possibility that they are like everybody else, overburdened with schedules they can't meet. To open that whole thing up again and go back in would take an enormous amount of time.

Mr. MOFFETT. Ms. Hobson, why don't you come up here and sit down. I see you shaking your head, and I want to know what you are shaking it about.

[Ms. Hobson resumes the witness chair.]

Mr. MOFFETT. Thank you. Can you respond to that?

Ms. HOBSON. Yes. I don't want to take more time, but I do want to indicate these gentlemen did not know that there was pressure. There was considerable pressure. At the February meeting, my office was not permitted to hand out a copy of the report, and I have a memo which I would be happy to state for the record. We objected.

It caused a scene within DOE because we handed the gasohol report out to the public, which you have to do under the Advisory Committee Act. Any documents belong to the public. I had to Xerox them in my office and hand them out at that meeting, because the ERAB group refused to. That's No. 1.

Two, they did not want to hear someone who came to speak from Barry Commoner's organization, and we had to ramrod that through and escalate it so they could speak. They wanted that report to go through with a minimum of discussion, and that's when our office became very angry, because we have oversight over this and that was just not good behavior in terms of the perception of the public. You would not approve of it, and we knew that that was the case.

Mr. MOFFETT. So what happened?

Ms. HOBSON. So what happened was we handed out the report and we secured permission for Dr. Commoner's representative to testify. So, ERAB delayed a vote until the May meeting. Then, when it came up at the May meeting, Amory Lovins was not informed so that he could come. He was the only one with significant knowledge about alcohol fuels who represented the public.

Mr. MOFFETT. OK, but where did the resistance come from? The Chairman of the Advisory Board?

Ms. HOBSON. The resistance came from John Deutch, the Under Secretary.

Mr. MOFFETT. From John Deutch, the Under Secretary of the Department of Energy.

Ms. HOBSON. That's right.

Mr. MOFFETT. How about the Chairman of the Advisory Board?

Ms. HOBSON. Sol Buchsbaum?

Mr. MOFFETT. Yes.

Ms. HOBSON. Yes; he did not want——

Mr. MOFFETT. And what is his position? Is he a Federal employee?

Ms. HOBSON. No; Sol Buchsbaum is not a Federal employee. He was a former Chairman of the Defense Science Board.

Mr. MOFFETT. And now works for the Bell System.

Ms. HOBSON. Right. He was formerly, I think, with one of the DOE labs or ERDA lab.

Mr. MOFFETT. So what we have here, and I think this is rather extraordinary, we have a high-level Government official and an employee of the Bell System in this case, the Chairman of this Advisory Board, exerting rather strong pressure not to have you do your job and not to open up this report.

Ms. HOBSON. I do want to say on behalf of the Chairman, Sol Buchsbaum, that I literally picked up the phone and told him that the Deutch memo, the draft memo existed, when Buchsbaum had promised me that it would not go to the Secretary because we knew it was a public issue prior to going to the full board. Buchsbaum was very upset. He obviously did not know that John Deutch had written that memo.

Mr. MOFFETT. So, this is in February now?

Ms. HOBSON. No; this is right after December.

Mr. MOFFETT. OK.

Ms. HOBSON. All right, this is on December 19, 20, something like that.

Mr. MOFFETT. So when you went in and said that you wanted copies—is that what you are saying, copies of the report?

Ms. HOBSON. Yes; at the February meeting.

Mr. MOFFETT. When was that?

Ms. HOBSON. At the February meeting.

Mr. MOFFETT. That was February; OK.

Ms. HOBSON. That was just the day before and the day of the meeting. There were about 20 people in the audience and we wanted to hand them copies of the report which was being discussed by the Advisory Committee at that time. My staff was refused copies of the report. So, I gave them my only copy, said Xerox it and hand it out to the public and I will assume the consequences. I was called on the carpet for that.

Mr. MOFFETT. By?

Ms. HOBSON. By ER, by the research office that handles ERAB.

Mr. MOFFETT. Well, the office didn't call you on the carpet. Who called you on the carpet?

Ms. HOBSON. Who called me on the carpet? I understand that Ed Frieman and Doug Pewitt—Doug Pewitt called me in because he is trying—Doug and I are trying to work this out and change it, and Ed Frieman also wants it changed.

Mr. MOFFETT. Now who are these people, just for the record?

Ms. HOBSON. These people report through the Under Secretary, Worth Bateman, who was the Deputy to John Deutch at the time. He is now the Acting Under Secretary.

All right, so it was just for some reason and I don't know why they didn't——

Mr. MOFFETT. He got a promotion, in other words.

Ms. HOBSON. He got a promotion, right, and he is the one Stelson, Tom Stelson, now reports through. So Bert reports through a Deputy that reports through Stelson that goes to Worth Bateman.

Mr. MOFFETT. I see.

Mr. FITHIAN. Would you yield for a question?

Mr. MOFFETT. I will yield, yes.

Mr. FITHIAN. I just have one question, now. When you attempted to make the study public at that point, what was Deutch's reaction to this?

Ms. HOBSON. John Deutch was not there, obviously; but, you see, we didn't ask to make it public. We simply made it public. After the fact, I understand people were furious. My staff tells me their staff was upset; everybody was upset that we made it public.

I went down and I showed ER the part of the act that says all documents, draft documents, memos, et cetera, all should be made available to the public. There's nothing in my office that isn't made available to the public. So I don't know why they didn't want it made available to the public at that meeting. Anyway, it was delayed, and the final decision was to vote on it at the May meeting, at which time Amory Lovins, the only person who disagreed with the report, was not invited.

Mr. FITHIAN. Interesting. Thank you, Mr. Chairman.

Mr. MOFFETT. Thank you very much. I think the record is very clear now as to what took place.

Let me go back, just really in closing here, Mr. Greenglass, to the issue itself, the gasohol issue. A viable ethanol industry could have many positive effects. Is one of them the retention of small family farms?

Mr. GREENGLASS. Yes; I believe it is. I believe it would go a long way toward that.

Mr. MOFFETT. Would you like to elaborate on that, Mr. Holmberg?

Mr. HOLMBERG. Mr. Chairman, I can't think of anything on the horizon in the farm community that has greater potential to revitalize not only the family farm, but the farm community. It's just not a matter of moving into the ethanol for a farm fuel. It's also moving into integrated farm systems that reduce their reliance on imported oil. There are gasifiers now that will permit us to make ammonia in the farming environment. Now there are different kinds of farming practices that reduce their reliability on energy-intensive and chemical-intensive farming.

Farmers are now becoming very alert to solar energy. They are very alert to their responsibilities to protect the topsoil and the water supply, and this is all good news. I see nothing but good news coming out of the American heartland. I just see sometimes the delays that we in Washington cause that keep them from getting on with their business.

If I could just add another dimension to that, all of this is very helpful to get on the record, but in all honesty, it keeps us from serving the public. We have to go back now and deal with the issues that flow out of these kinds of meetings, and it keeps us from working with the farmers. It's sort of a double-edged sword. We have to get it on the record, but by getting it on the record, now we have to deal with it bureaucratically.

Mr. MOFFETT. What do you mean by that? That's an interesting observation.

Mr. HOLMBERG. Well, we have x amount of hours to work. We have y amount of staff. We can take those resources and use them to serve the public or we can take those resources and deal with the bureaucracy.

Mr. MOFFETT. What do you mean by bureaucracy, though?

Mr. HOLMBERG. Well, clearly after an event like this, we go back and we have got a lot of work to do.

Mr. MOFFETT. Explaining to do?

Mr. HOLMBERG. Explaining to do, memos to write, yes, and procedures to put in place.

Mr. MOFFETT. Well, I think that the subcommittee—which I think you know—this rather active subcommittee has the same goal in mind that you do with regard to unleashing your office. And to the extent that you get bogged down in writing memos and reacting to the bureaucratic fallout from our uncovering this outlandish sequence of events that took place, we will be of assistance to you.

I am sure Mr. Fithian, who has been working almost full time in this one area, will keep on the Secretary's Office and the Under Secretary's Office to see that you are able to do your job.

Mr. HOLMBERG. I think the real mission now is to be of service to the small industries and the farm communities.

Mr. MOFFETT. Well, let's talk about that for a minute. We have got one-half a billion dollars, as I understand it, in loan guarantees to go out. Anyone who has ever done business with the Federal Government has to know that there's a fairly good chance that that money can be largely wasted; I know this in my own area from having corporations like United Technologies and others who are involved in alternative energy, whether it's wind power or solar, what-have-you. What I hear time and time again, and I am sure it's true in this area with this particular energy alternative that we are talking about, is that the Federal Government can do a fairly good job at research and development; but, when it comes time to help build an industry, the commercialization part of it, that people in the Federal Government lost, that they don't understand. A lot of them have never been businessmen before; they don't really understand what it takes.

So part of what we are trying to get at here is, say, what in the world is going to become of this one-half a billion dollars. As I said, I was on that House Senate conference committee; and I am not content—and I know Mr. Fithian and Mr. Deckard aren't content and no one on our subcommittee is content—to just walk away from that now and to announce to the public, well, your salvation is here: We have approved one-half billion dollars in loan guarantees.

How is this money going to be spent? How, let me be blunt about it, are we going to prevent the same old faces and the same old refugees from ERDA and the same old crowd, as we saw in operation in this episode here, from really controlling where that money goes? In other words, we want it to hit the market and we want you to tell us how it can best hit the market. We are going to keep on this program and on this Department to see that it does hit the market, but what are your plans?

Mr. GREENGLASS. I think there are some pitfalls in the statement you made, Mr. Moffett. First, the $500 million that we have been given are for plants of 15 million gallons or more, which means at best we are talking about 20 loan guarantees at most.

Further, based on the interpretations we have received to date on that legislation, we cannot use any of those funds to support the industry itself. Giving out loan guarantees isn't going to make the industry. It's going to help production, go a long way toward providing incentives for production, and it will help bankers realize that it's a good investment. It will not help producers get their allocations of unleaded gas from the oil refineries; it will not help them get State assistance when they need it, to get the appropriate approvals. It will not help the consumer or the industry become aware of potential pitfalls of components and equipment that people run into very quickly. Moneymakers run very quickly into new industries.

There really isn't an opportunity to do the things that really need to be done with that $500 million.

Mr. MOFFETT. Is that your interpretation based on the DOE interpretation of the legislation? There is more than one way to interpret that legislation.

Mr. GREENGLASS. I agree with you, and I wish we could get a better interpretation. That's the interpretation provided to me by the Office of General Counsel of DOE. It's an unfortunate interpretation, because it binds us.

I'd also like to take the opportunity to say that I think the Office of Alcohol Fuels has been composed of people who are quite pragmatic and familiar with industry, both small and large scale. I think what Bill was trying to say a moment ago is that we are prepared to execute the intent of your legislation, and we fully feel that we are capable of doing that providing we have sufficient funds and resources to do.

Mr. MOFFETT. There will be a rulemaking, won't there?

Mr. GREENGLASS. Yes; There will be a rulemaking.

Mr. MOFFETT. Well, I think it's safe to predict that those of us on this subcommittee and others who are concerned about this will involve ourselves in that rulemaking. Too often, Members of Congress are content to just pass legislation and then not go down and say to the agency, this is what we meant. As Members of Congress and as citizens, for that matter, we are prefectly eligible to go down and say this is what we meant. I would not only bet, I would promise you that those of us who were on the House Senate conference committee and people such as those we have on the subcommittee will be pressing the Department of Energy to make the best use of that and will be offering some clarification on what we think the interpretation should be.

Mr. HOLMBERG. Could I add a dimension to that, please?

Mr. MOFFETT. Certainly.

Mr. HOLMBERG. You indicated that there was a possibility that that $500 million made available to DOE just could possibly disappear into the woodwork without any real impact on the industry, and I would agree with that. That potentially is there.

I would also say that we have the flexibility to implement the policies as we see them, to get the technology, to get the education, to get the money out to where it really counts. That $500 million is plenty of money, and we can do it.

Mr. MOFFETT. Well, but where does the flexibility come from? Was it that we on the conference committee didn't give you the flexibility or is it the DOE's interpretation that is not giving you the flexibility?

Mr. GREENGLASS. I would, if I may, like to say that really both are problems, first by limiting DOE to 15 million gallons or more and not providing us with sufficient funds for research and development and the development of cellulosic conversion. That in itself was a problem.

Mr. FITHIAN. May I just make a comment here, Mr. Chairman?

Mr. MOFFETT. Certainly. I would be happy to yield to you.

Mr. FITHIAN. I got a small group of Republicans and Democrats together early on in the hammering away on—Tom Foley and others who were on the conference with me—and there has been a very, very long history of difficulties between the Department of Energy and the Department of Agriculture over the issue of alcohol fuels; and we were months and months and months getting the two Secretaries to execute a memorandum of agreement, as I am sure you are aware, Mr. Greenglass.

The thought behind the way they divided the money was that the Department of Agriculture, with its farflung county extension agent system in soil conservation, farm home administration and all of the mechanism that's already in place, and with its experience of dealing with agricultural problems and farmers and it is the trust that the local county extension agent has—that is, the trust he has with the

farmers—led us to believe that the small production facilities ought to be handled through USDA. I still believe that was a wise division: The small plants with USDA and the large ones with you. I realize that there's a gray area in the middle for the co-ops and, depending upon their size, whether they fall under your category, under your jurisdiction, or USDA's.

I just wanted to enter for the record here that it was not happenstance that the Synthetic Fuels Conference came out the way it did. That was the way it was divided. It was divided intentionally. Congressman Bedell and a number of us in the alcohol fuels caucus fought in fact for that division, and I think it's a good division.

Mr. HOLMBERG. Could I add to that, please?

Mr. MOFFETT. Yes.

Mr. HOLMBERG. I don't think we have any real problem with the division of 15 million gallons, but we have our problem, for example, in the educational area. The Department of Energy, through the Office of Consumer Affairs, started the educational program in community and junior colleges and vocational technical schools. We have a whole industry here that we have to train and get up to speed. We are just beginning that effort.

We have been told that the legislation of S. 932 precludes us from following through on that. We have 40 community colleges and maybe 100 out there now are developing educational programs that rely on us for funding.

Mr. FITHIAN. Well, if I may, in rough, I think that that is a perversion of the act—not what you are saying but a perversion of the intention of the act. So clearly down in one of the sections taken from Senator Talmadge's bill is the technical assistance provision program and that's precisely what we are talking about. It is very badly needed. I hope that through yourselves and the USDA that we can further that program.

I think it's clear, Mr. Chairman, that if we, our subcommittee, persisted in trying to push forward on that, we could get a clarification that would ease that, because nothing in that act was designed to in any way restrain the Department of Energy or the Department of Agriculture from doing exactly what you are saying and, that is, to get the technical assistance information out there so that farmers are not sold the Brooklyn Bridge, so to speak.

Mr. HOLMBERG. Let's make the assumption that that is true; but then in the funding, the Department of Agriculture received $10 million for educational programs and DOE received nothing. So even though DOE has the flexibility to do it, if you don't have any funds, it's kind of hard to provide a service to vocational schools, community and junior colleges that depend on us for that kind of support.

Mr. GREENGLASS. I wonder if I could also make the point that I think that the logic you presented supports the decision made for the split in levels of production. I don't question that.

I do agree with your point very strongly that it is the interpretation of that split that has created a problem. Our relationship with Agriculture has improved considerably since the establishment of the Office of Alcohol Fuels. Alex Mercuri is now the keyman who works with us, and he is doing a fine job. That relationship is going a long

way toward alleviating any voids in the area that we are required to address under the program.

As interpreted, the result of that split says that the Department of Energy is primarily interested in large industry—by definition. It also says that we are not in a position to support the development of the industry itself but simply to provide incentives for financing the industry, resulting in the potential occurrence of all the pitfalls that would, in fact, make the Federal Government look poor in the development of a new industry.

I have had experience in working in the development of other industries, and I can tell you that financing of the production itself is totally inadequate to the success of that new industry. We need considerably more funds and research and development in overcoming the barriers that the industry is going to face.

Mr. MOFFETT. Gentlemen——

Mr. HOLMBERG. I will give you another example, if I could.

Mr. MOFFETT. Yes.

Mr. HOLMBERG. We have the Office of Small-Scale Technology that comes out with grant applications, and we purposely tried to focus on those small-scale grant applications that relate to alcohol fuels. We identified about 250, nationwide, that were worthy of funding. This is an exciting opportunity to get that technology moving very quickly, and we have been told by Counsel that we have to go through a set of bureaucratic steps in order to fund those small-scale grants. We are looking for ways of moving this thing quickly. I think that's a very important lever, down at those farm and small laboratory levels.

Mr. MOFFETT. Thank you, gentlemen. We thank you for your statements here and your candid testimony. I can assure you that a couple of things will be done as a result of it.

Number one, as Congressman Fithian has just indicated, we will as a subcommittee—and I have instructed staff to begin this process—move to clarify the legislation and to work for the best possible interpretation of the legislation.

Second, I have also instructed staff to communicate on our behalf to the Department a message that indicates that we want you folks to be able to do your job and not be detained or distracted by bureaucratic considerations over this particular hearing.

So, we thank you very much and look forward to working with you.

[Mr. Greenglass' prepared statement follows:]

STATEMENT OF BERT GREENGLASS, ACTING DIRECTOR, OFFICE OF ALCOHOL FUELS

Mr. Chairman and Members of the Committee:

Thank you for this opportunity to discuss the Department's response to the April 29, 1980 Report of the Gasohol Study Group of the Energy Research Advisory Board [ERAB] on Gasohol.

By way of introduction, I am the Acting Director of the Office of Alcohol Fuels and have been serving in this capacity since May 27, 1980, when Secretary Duncan appointed me to succeed E. Stevens Potts. Prior to my appointment, I was Acting Director of the Office's Program Control and Evaluation Division, serving almost from the day the Office opened its doors in late February.

Following releases of the ERAB Gasohol Report on April 29, 1980, the Secretary of Energy directed the Office of Alcohol Fuels to review and respond in detail to the ERAB Report's recommendations and report back to him. We have completed our technical review of the ERAB Report and we expect to forward our position on it to the Secretary in the immediate future.

The Office began its review of the ERAB Gasohol Report virtually the day we received it. Our review has been a detailed and technical one, and includes information provided by the Solar Energy Research Institute, the National Alcohol Fuels Commission, EG&G Idaho, Inc., the National Alcohol Fuels Producers Association, Congressional staff members and several other groups and individuals. Some of the country's most knowledgeable people in

the alcohol fuels field, including many with hands-on alcohol production experience, reviewed our June 3 draft response, and submitted their own comments and criticisms. Thus, the final response before you today represents current thought and experience of fuel alcohol pioneers on the frontier of this developing technology.

I would like to summarize some of our preliminary findings of our technical review for you today. They are:

1. The Nation can and will meet the Administration's ethanol production capacity goals, as well as those set by Congress in the Energy Security Act of 1980 (P.L. 96-294). The Gasohol Study Group estimates for 1985 ethanol production, which did not predict later significant Administration and Congressional alcohol fuels initiatives, are thus out-of-date. For example, one company may produce the ERAB Study Group's 1985 production estimate by the end of 1981.

2. Production of ethanol from biomass is commercially available and in widespread operation throughout the country today. The growing alcohol fuel industry is already reducing our dependence on imported oil through increasing domestic ethanol production.

3. Many technological and energy-saving advances in ethanol production processes are occurring at an accelerating pace. Ethanol producers in many parts of the country are realizing substantial energy gains now and expect even greater efficiencies in the near term. With these advances, the net energy balance of alcohol fuel production will continue to improve.

4. Administration and Congressional ethanol production and capacity goals can be met without an adverse effect on food supplies or prices. There are significant opportunities to use agricultural and food processing waste products and to develop high-yield energy crops for substantial production of ethanol, thereby reducing cost to the consumer. Further, the ethanol from grain process produces valuable, protein-rich co-products which are suitable for export and domestic use.

5. Farm-scale ethanol production can strengthen the family farm by generating a steady cash flow to farmers while providing an uninterruptible supply of high-grade liquid fuel to power farm machinery.

It must be remembered that the ERAB Gasohol Report was undertaken on a "quick turn-around basis," according to ERAB Chairman Dr. Soloman J. Buschsbaum. The Gasohol Study Group met for two days, on December 10 and 11, 1979, and at that time, by all accounts, the Group agreed upon a number of findings and recommendations. They issued a draft report two days later, on December 13, 1979. While the Group submitted its final Gasohol Report to the ERAB Chairman on April 29, 1980, the study was conducted in December 1979.

The following events, which have had substantial impact on alcohol fuels development, occurred during the first four months of 1980, after the study was conducted but before the final ERAB Report was submitted to the Secretary:

1. On January 11, 1980, the President announced a comprehensive National Alcohol Fuels Program to accelerate domestic production of alcohol fuels from non-petroleum sources. The Program seeks to quadruple January 1980 alcohol production capacity by the end of 1980, and sets a target for domestic production capability of 500 million gallons during 1981.

2. On February 14, 1980, the Office of Alcohol Fuels was created within the Department to promote ethanol production from biomass, and to implement the DOE Alcohol Fuels Program.

3. On April 2, 1980, the Crude Oil Windfall Profit Tax Act of 1980 (P.L. 96-223) was signed into law by the President. Among other incentives, the act continued the four cent per gallon federal excise tax exemption for gasohol for eight more years, from 1984 through 1992; provided new income tax credits for alcohol-gasoline blenders; and extended through 1985 tax credits for alcohol fuel production equipment.

4. The Energy Security Act of 1980 (P.L. 96-294), containing additional financial incentives to stimulate alcohol fuels from biomass production, was advancing through Congress with increasing assurance of passage.

5. Demand for gasohol at the pump steadily increased, with the number of service stations throughout the country offering gasohol to motorists nearly doubling. Incidentally, today there are over 5,000 stations selling gasohol in the country.

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I do not think it is necessary to explain to this Committee the significance of these Congressional and Administration initiatives. Members of this Committee were instrumental in moving the Crude Oil Windfall Profit Tax Act (P.L. 96-223) and the Energy Security Act (P.L. 96-294) through the Congress. Likewise, the Secretary recently testified before the National Alcohol Fuels Commission on the Department's strong commitment to increased production and use of alcohol fuels, when he stated:

> The Department of Energy is committed to two objectives in this area: to achieve the President's alcohol fuels production target and to implement aggressively the mandates of Congress. This effort is already underway.

It should suffice to say the conditions affecting domestic alcohol fuels development changed dramatically in the first four months of 1980. These changes, as evidenced in the events described above, and their likely impact on the development and production capacity of the growing alcohol fuels industry, were not considered by the Gasohol Study Group, nor were they factored into the findings and recommendations contained in the Report. The final ERAB Report was significantly out of date at the time of its release as a result of far-reaching Congressional and

Administration alcohol fuels initiatives which occurred in the intervening period.

Nevertheless, it is essential that we address the hard issues presented by the challenge of developing a new industry such as alcohol fuels. Some of these issues are technical in nature, and our response attempts to address the two most prominent issues raised in the ERAB Report: the question of food versus fuel and the net energy balance of ethanol production.

The Secretary of Agriculture recently testified before the National Alcohol Fuels Commission and stated, "Distillation capacity, not agricultural feedstocks, is currently the restraining factor on fuel alcohol production. At the present time, adequate supplies of corn and other fermentable commodities are available from the market at competitive prices." (Cyclical weather patterns will, of course, affect the availability and price of agricultural feedstocks.) Secretary Bergland further stated that "As matters now stand, we don't think [the food versus fuel issue] is a serious question because a modern recovery system can convert starch and leave protein." He then added that he did not anticipate any food shortages as far as our country is concerned.

The Office is currently exploring the vast potential of ethanol production from agricultural and food processing waste products, high-yield energy crops and new technologies in cellulosic conversion. Developments on these fronts offer the possibility of substantial ethanol production capacity without significant impact on food supplies by the mid-1980's. It must also be remembered that, when grains or other edible feedstocks are used in the ethanol production process, a portion of the feedstock is converted to valuable protein-rich co-products, such as corn gluten meal or distiller's dried grain, which are suitable for export and domestic use.

When the food versus fuel issue is raised, it is often implied that were corn or other feedstocks not used for alcohol production, they would go toward feeding the world's poor. However, ninety percent of the whole corn sold in this country goes to cattle feed. Most exported corn goes to developed countries where it is used for animal feed. Thus, for the most part, this grain is not used to feed the world's poor in underdeveloped countries. Yet this animal feed market could be further developed by exporting protein-rich distiller's grain or wet and dry milling concentrates that can be combined with local carbohydrates and forage crops to balance the feed rations.

The net energy balance issue was also raised in the ERAB Gasohol Report, which concluded that "utilizing the best available technology before 1985, the net energy balance is about zero for ethanol produced from corn and other crops in fermentation/distillation plants. If the fermentation/distillation plants are fueled by coal or wood, each gallon of ethanol produced could save roughly 0.5 gallons of oil." ERAB used very conserative assumptions in arriving at this conclusion. They also considered, but did not emphasize, an alternative calculation in which almost a gallon of oil would be displaced by a gallon of ethanol.

There are two points which must be kept in mind in any discussion of net energy balance for alcohol fuels production. First, technological and energy-saving advances in production processes are occurring at an accelerating pace, resulting in substantial energy gains now and even greater energy efficiencies in the near term. With these advances, the net energy balance of alcohol fuel production will continue to improve.

Second, energy balance is a non-issue to the extent that domestic ethanol production (utilizing non-petroleum sources) reduces our dependence on imported oil, thus contributing to our balance of payments and national security.

At a recent hearing on gasohol allocation before the Economic Regulatory Administration, one major oil company estimated that for every barrel of ethanol used as a gasoline blending component, gasoline yields could be increased by as much as two barrels.

The U.S. General Accounting Office, in a June 3, 1980 Report on the potential of ethanol as a motor vehicle fuel, addressed the net energy issue and stated:

> Our work in the area has shown that net energy analysis is not an exact science; therefore, any two or more studies of a particular energy system can yield vastly differing results, depending on the methodologies, approaches, and systems boundaries selected. There is also a tendency to overemphasize net energy aspects of ethanol as a fuel, thereby losing sight of the real objective: producing usable liquid fuels. For example, using coal to fire the distilleries to process grains and other crops into ethanol may, as some studies show, result in a net energy loss. But the process produces a fuel which is more readily adaptable for certain uses (e.g., motor vehicle fuel).

I support this position.

In conclusion, the National Alcohol Fuels Program will achieve the production capacity goals announced by the President as well as those set by Congress in the Energy Security Act of 1980 (P.L. 96-294). These goals can be met without an adverse effect on food supplies or prices. Domestic ethanol production is already reducing our dependence on imported oil. With techno-

logical and energy-saving advances now coming on-line, we are beginning to realize substantial energy gains. And the net energy balance of alcohol fuels production will continue to improve.

But there is much work ahead to achieve these goals. Constraints and barriers to alcohol fuel production and marketing must be identified. Regulatory requirements must be streamlined to bring additional ethanol production capacity on line as soon as possible, and research and development must be directed toward the numerous opportunities to make ethanol production processes even more energy efficient.

The ERAB Report is behind us. At this time, we must move ahead to develop and promote the fledgling alcohol fuels industry and to meet the ambitious but achievable goals for alcohol production the President and the Congress has set.

Mr. Chairman, this concludes my prepared testimony. I would be pleased to answer any questions.

Mr. MOFFETT. Our next witnesses will appear as a panel, and we will have three gentlemen: Dr. Robert Peart from Purdue, Dr. Michael Ladisch from Purdue, and James Childress, the Executive Director of the National Alcohol Fuels Commission.

Please raise your right hand. Do you swear to tell the whole truth and nothing but the truth, so help you God?

[Chorus of "I do."]

Mr. MOFFETT. Thank you for being with us today. Without objection, your statements will be considered a part of the record. You may proceed by reading those statements or paraphrasing them.

We will begin at my left and go across. Please proceed.

STATEMENT OF JAMES CHILDRESS, EXECUTIVE DIRECTOR, NATIONAL ALCOHOL FUELS COMMISSION

Mr. CHILDRESS. Thank you, Mr. Chairman. I am James Childress, Executive Director of the National Alcohol Fuels Commission. I appreciate the opportunity to appear here on behalf of Senator Bayh in his role as Chairman of the Commission. Senator Bayh feels very strongly that the hearings you are holding today on the ERAB gasohol report are making an important contribution to the public debate on gasohol. He especially commends you for making this forum accessible to the people of Indiana who are going to play a critical role in this industry.

In the interest of time, I will summarize my testimony and ask that it be submitted for the record in its entirety. I will not repeat anything Mr. Greenglass has said in his point-by-point critique of the ERAB report, but do concur in his presentation.

Senator Bayh directed the National Alcohol Fuels Commission staff to evaluate the ERAB, shortly after its release to see what contribution it could make to our ongoing study. My testimony this morning is based upon that evaluation.

The two principal conclusions of the ERAB report—those being that we can expect a sustained level of grain ethanol production of no more than 800 million gallons per year and that each gallon of ethanol produced can displace no more than half a gallon of gasoline—cannot be supported, and are in fact refuted by research undertaken by the National Alcohol Fuels Commission.

The Congressional Office of Technology Assessment, in a report released today, also disagrees entirely with both of these conclusions of the ERAB report. This is an exhaustive, responsible report that OTA has completed.

I would like to concentrate in my testimony today on one issue that has been raised in the ERAB report and dealt with often in the press on an emotional basis with little analysis or basis in fact. That's the so-called food-versus-fuel issue.

While the ERAB report does not explicitly state it, I believe that its maximum production level of 800 million gallons per year is based upon an assumption that the limiting factor will be the availability of grain, primarily corn, as a distillery feedstock. One quote in particular out of that study should be noted:

> Gasohol production, stimulated by high subsidies, will reduce the amount of grain available for meat, milk, and egg production.

These are obviously very serious concerns. They are critical to an expanded alcohol fuels program. The Alcohol Fuels Commission, in response to these concerns, requested the highly respected agricultural policy and economic consulting firm of Schnittker Associates of Washington, D.C., to undertake an exhaustive analysis of the effects of alcohol fuels production on the cost and availability of food over the next 10 years. I have provided, or I will provide, the subcommittee with a copy of that draft report which will be made publicly available within the next couple of weeks. I will summarize its principal findings this morning.

For purposes of the study, it was assumed that growth in grain demand, worldwide and in the United States, will continue and would continue at a fairly healthy rate. We asked them to be overly conservative in their assumptions; that is, err in favor of assuming we are going to have a continued high demand for grain for food and fuel.

The net effect was that grain prices would increase, on the average over the next 10 years, at the level of the rate of inflation—which, as you know, Congressman Fithian, has not been the case over the past 10 years in which grain prices, corn prices, have fallen below the level of inflation. In other words, we assumed that there will be an increase in grain prices over and above what it has been in the past.

Given these very responsible assumptions, the key finding was—if there is no special effort made over the next 10 years to bring new land into production, to provide extra incentives for alcohol fuels production, without any special efforts whatsoever—that a sustained level of production of 1 billion gallons a year of ethanol can be achieved using corn alone as the feedstock. This base case alone refutes the findings and the conclusions of the ERAB report.

We then asked Schnittker Associates to go beyond this baseline case and to see what levels of 2 billion gallons per year by 1985 and 4 billion gallons per year by 1990 would do to the cost and availability of food and feed. To state the findings very briefly, the principal effects would be increased corn acreage and production, a reduced demand and lower acreage for soybeans, and a dramatic increase in supplies of corn milling byproducts. All of these are to be expected, and these are the points that are usually raised in discussing the effect of increased ethanol production from corn.

However, the analysis indicates that many of the problems do not necessarily follow. With a 2-billion-gallon level of ethanol production by 1985 and the same thereafter, we could expect real corn price increases of approximately 8 percent. That is over and above the level of general inflation. The 4-billion figure in 1990 would result in approximately a 15-percent increase in real corn prices over the intervening period of time.

If we worked this through the food system, and again making very generous allowances for overall inflation rates, there would be an approximate 6.5-percent increase in overall food prices during the decade over and above what would be expected. That is approximately six-tenths of 1 percent per year inflation in food costs over what would normally be expected if this ethanol production program were not in place, and that's at a level of 4 billion gallons per year by 1990. Again, I would like to emphasize that these estimates are on the high side.

The principal effects would be a reduction in soybean acreage because of the cheaper byproducts from the ethanol distillation; there would be significant amounts of the byproducts. However, the study does not foresee a problem asborbing these into the domestic and foreign feed systems if the program is phased in over a period of 10 years, as it will be, because of the constraints on available distillery capacities.

Finally, the study found that increasing the use of corn for ethanol production will not create a long-term problem of food for developing nations for two reasons. First, it's primarily wheat and rice, not corn, that go to the developing nations as food. Second, the small amounts of corn that actually go as food to developing nations could be made available for that use under a program such as outlined in the study.

I think the essential message of the Schnittker report is that we can proceed with an active alcohol fuels program, relying initially on grain-to-ethanol technology, with no fear that we will reduce the amount of grain available for meat, milk, and egg production.

The critical flaw in the ERAB report was its failure to take into account the fact that rising corn prices would also spur increasing corn production. It is basic economics—and when you live west of the Allegheny Mountains people realize this—that if you get a better price for corn, you are going to produce more corn. We are not going to create an ethanol "China syndrome" in which runaway ethanol production will deny us of an adequate supply of corn.

There is one cautionary note. An expanded program of fuel alcohol production will have to have safeguards against one or two bad crop years. In testimony before the Commission in June, Secretary of Agriculture Bergland indicated that he feels that reserve policies are flexible enough to accommodate ethanol production in addition to other commodity production by the American farmer. Toward this end, Senator Bayh has introduced the Energy Independence Grain Reserve Act, which has passed the Senate. It would earmark grain for ethanol production and establish a reserve system to assure adequate supplies at relatively predictable prices for alcohol fuels producers even during bad years.

In summary, I think what we need here, Mr. Chairman, is perspective. The Schnittker report to the National Alcohol Fuels Commission has indicated that we can increase ethanol production from corn in the next 10 years to 25 to 30 times the present level of production, with only moderate inflationary impacts and with no effect on the availability of food to the hungry of this world.

Now when we are looking at a 25-fold to 30-fold increase, that is, getting up to 4 billion gallons of ethanol production using one commodity in which the increments on the average of plants are, I am sure, less than 5 million to 10 million gallons a year, this is going to be a phased-in program and there are going to be safeguards along the way. We are not going to have a runaway program in which we are grinding up corn for the Nation's gas tanks with no thought nor control over what the effects on food cost and availability will be.

Thank you, very much.

[Mr. Childress' prepared statement follows:]

STATEMENT OF JAMES M. CHILDRESS, EXECUTIVE DIRECTOR, U.S. NATIONAL ALCOHOL FUELS COMMISSION

Mr. Chairman, I appreciate the opportunity to appear here today on behalf of Senator Bayh in his capacity as Chairman of the National Alcohol Fuels Commission.

Senator Bayh feels very strongly that the hearings you are holding today on the ERAB Gasohol Report are an important contribution to the public debate on alcohol fuels and commends your efforts to air these critical issues in a forum accessible to the citizens of the State of Indiana who will play a major role in the development of gasohol as an alternative fuel.

The National Alcohol Fuels Commission, as part of its study of the potential contribution that alcohol fuels can make in reducing our oil dependence, has been addressing most of the issues dealt with in the Department of Energy's Energy Research Advisory Board Gasohol Study Group Report. When the ERAB Report was made public, Senator Bayh directed the Commission staff to evaluate it to determine what contribution it could make to the research being carried on by the Commission. My testimony this morning is based on that evaluation.

I would like to address one very specific topic covered in the ERAB Report -- the relationship between ethanol production and food prices -- but would first like to make two general comments on the overall report.

First, research by the National Alcohol Fuels Commission cannot support, and in fact refutes, the two principal conclusions of the ERAB Report -- that we can expect a sustained level of grain ethanol production of no more than 800 million gallons per year, and that each gallon of ethanol produced will displace no more than one-half gallon of premium fuel.

Second, the flaws in the ERAB Report can best be explained in the transmittal letter from the ERAB Chairman to Secretary Duncan which characterizes the report as having been "undertaken on a quick turnaround basis" using the "best available data" at the time the study was conducted -- December 1979. That may not seem like a long period, but given the original research, study and analysis that has taken place in the intervening seven months by the National Alcohol Fuels Commission, Office of Technology Assessment, Solar Energy Research Institute, Departments of Energy and Agriculture, universities, and the private sector, the ERAB panel was in many instances working with outdated information.

I will not attempt a point-by-point critique of the report's findings and recommendations. That has been done more than adequately by others, especially the Department of Energy's Office of Alcohol Fuels. I would like to concentrate instead on an issue raised in the report that is often dealt with emotionally, with little analysis or basis in fact -- the so-called Food versus Fuel issue.

While the ERAB Report does not explicitly state it, I assume that its maximum 800 million gallon per year ethanol production figure is based upon an assumption that the limiting factor is the availability of grain -- primarily corn -- as a distillery feedstock.

The report addresses grain availability as follows:

> "Gasohol production, stimulated by high subsidies, will reduce the amount of grain available for meat, milk, and egg production."
>
> . . .
>
> "The pool of grain available for gasohol and livestock production is projected to decline in the future because of the rapidly growing world population and demand of this grain for food. Even without gasohol production projections are that both demand and prices for grain on the world market will increase."
>
> . . .
>
> "Basically because livestock and gasohol production use the same resouce, they will compete for surplus grain."

These are obviously serious concerns. No one wishes to undertake an expanded program of energy production that would jeopardize our food supply and grossly inflate food prices. Because the issue is critical to an expanded alcohol fuels program in this country, the Alcohol Fuels Commission requested the highly respected agricultural policy and economic consulting firm of Schnittker Associates of Washington, D. C. to undertake an exhaustive analysis of the effects of alcohol production from corn on the cost and availability of food over the next ten years. I have provided the Subcommittee with a copy of the report which will be released to the public within the next few weeks. I will summarize the report's principal findings.

For purposes of the study, it was assumed that increasing world population, continued growth in real per capita incomes with an associated rise in demand for meat and poultry would generate a rapid increase in world demand for grain and oilseed used in this decade. U. S. export of grains was expected to continue its rapid rise.

The net effect of these factors is that grain prices were assumed to increase, on the average, as rapidly as the general rate of inflation, a more rapid increase than that experienced during the past 10 years.

With these very responsible assumptions, the study found that without any special efforts to increase production by expanding the amount of land under cultivation or irrigation or by other means, and without reducing U. S. feed supplies or exports, or without causing grain prices to rise faster than others, a level of production of over 1 billion gallons of ethanol per year can be sustained. This allows for all other uses, including substantial increases in total carryover and reserve stocks to match the rising level of total demand. This finding alone refutes the ERAB production figure.

The study then went beyond this "baseline case" to determine the effects of going to levels of 2 billion and 4 billion gallons of ethanol production per year in 1985 and 1990 respectively.

The findings may be briefly stated: The principal effects of such a program would be increased corn acreage and production, reduced demand and lower acreage for soybeans, and dramatic increases in supplies of corn milling by-products. None of this is surprising.

The increased corn acreage and production would be brought about by increased real prices for corn resulting from the demand created by the ethanol production. Producing 2 billion gallons of ethanol in 1985 would increase real corn prices 8 percent. (That is above price rises that could be expected if corn prices follow inflation.) The 4 billion gallon production figure in 1990 would result in a 15 percent real price increase for corn, compared with the baseline case.

Worked through the food system, with generous assumptions on the price effects on all other agricultural commodities, the consumer price index for food would increase 6.6 percent from 1980 to 1990 over the baseline case. This is a maximum figure, since the prices of some domestic commodities and most imported commodities would not be affected by an ethanol program. Stated another way, for the period 1980 to 1990 we could expect at most a 6.6 percent increase in food prices above levels expected due to inflation. The overall consumer price index effect for the 10-year period would be a little over 1 percent. I emphasize that these figures are probably on the high side.

The reduction in soybean acreage would be due to the competition from the less expensive distillation by-products as protein feed supplements and from the switch to corn because of increased demand. While soybean acreage would drop, actual production would increase because of increased yield. Soybean meal would remain the leading protein by far. Most of the growth in the market, however, would be taken up by the distillation by-products.

The report indicates that the significant amounts of by-products generated will be absorbed, to a large degree, through exports, especially in Europe and Japan which have large and growing animal, poultry, and feed manufacturing sectors.

Finally, the report found that increased use of corn for ethanol need not affect food supplies for developing countries, either severely or directly, given the fact that wheat and rice are the principal export food grains to these nations, both for long-term and emergency situations.

The essential message of the Schnittker Associates report is that we may proceed with an active alcohol fuels program, relying initially on grain-to-ethanol technology, with no fears that we will reduce the amount of grain available for meat, milk, and egg production.

The ERAB Report did not take into account the fact that America's farmers would respond to increased demand for corn by producing additional corn. Elementary economics indicate that an increase in price will also increase supply.

The flexibility to shift acreage from soybeans to corn, and thus increase corn production to meet demands for ethanol production, is there. Such shifts would be no more dramatic than the growth in soybean acreage over the past 20 years (an almost threefold increase), the rise in demand for corn sweeteners, or the shift in demand away from beef and pork to poultry. In each of these instances, rather dramatic structural changes have occurred in the industries involved over a 10-20 year period, primarily in the response to market and technological factors. Yet in no instance have there been any serious economic or resource adjustment problems, illustrating the considerable flexibility inherent in the U. S. food and agricultural sector.

An expanded program of fuel alcohol production will also obviously have to incorporate safeguards against one or two bad crop years. In testimony before the Natioal Alcohol Fuels Commission in June, Secretary of Agriculture Bergland indicated that he felt that reserve policies could be tailored to incorporate considerations of alcohol fuels production. Senator Bayh has introduced the Energy Independence Grain Reserve Act which passed the Senate last Friday for just such a purpose. It would earmark grain for ethanol production, and establish a reserve system to assure adequate supplies and relatively predictable prices for alcohol fuels producers even during bad crop years.

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In summary, I believe that the information now available to the National Alcohol Fuels Commission, gathered in a thorough, and technically defensible manner, refutes the contentions in the ERAB Gasohol Report that serious food price and availability problems will arise from an expanded alcohol fuels program.

Thank you. I will respond to any questions.

Mr. FITHIAN [presiding]. Thank you, Mr. Childress.

Now we will move to the other two panelists, and then we will open it for questions. Do you want to flip a coin to see who proceeds first, or how do you want to do it.

STATEMENT OF DR. ROBERT M. PEART, PROFESSOR OF AGRICULTURAL ENGINEERING, PURDUE UNIVERSITY

Dr. PEART. Thank you, Mr. Chairman, I am Dr. Peart, a professor of agricultural engineering at Purdue. I would like to enter testimony on the record and also the very recent publication, No. EC-511, written by Dr. Doering and Dr. Tyner of the Department of Agricultural Economics on "Alcohol Production from Agricultural Products." They have some pertinent things to say in that report.

Mr. FITHIAN. Without objection, it will be a part of the record.

[The material follows:]

EC-511

Alcohol Production from Agricultural Products:

An Update on the Facts and Issues

COOPERATIVE EXTENSION SERVICE, PURDUE UNIVERSITY, WEST LAFAYETTE, IN

Contents

NEW 5/80

Alcohol Production from Agricultural Products: An Update on the Facts and Issues

Otto C. Doering III and Wallace E. Tyner*

Why is it that people suddenly are interested in alcohol production? There are two reasons. First, we are finally recognizing the nature of our most immediate energy problem; and second, OPEC countries have recently changed the economics of oil as compared with potential oil substitutes.

While the United States is blessed with abundant supplies of coal, it has only a limited quantity of oil. Thus, the critical need is for liquid fuels. Almost half of the energy we consume is liquid--in the form of petroleum--yet less than 5 percent of our own energy resources are in the form of petroleum. As a consequence, we are importing almost one-half of our liquid fuel requirements.

Recent oil price increases have pushed the price of petroleum to the point where alcohol production may soon make sense economically, even without government subsidies. Shale oil and coal liquefaction are still more expensive, but the gap is being narrowed rapidly. The liquid fuel problem is so severe that it may well be in our best national interest to embark on the production of non-petroleum liquid fuels even if they are more expensive than imported oil.

However, if an alternative liquid fuels program is carried out, we must recognize that even on a massive scale, such a program would require many years of effort before its effect on the high volume of oil we import will be felt. This can only be accomplished by a long term, deliberate and thoughtful combination of research and development of alternative fuel sources, coupled with a demanding conservation program for available and existing liquid fuel materials.

* The authors are Associate Professors of Agricultural Economics, Purdue University. Much of the technical information was obtained from Michael R. Ladisch, Associate Professor of Agricultural Engineering.

FUEL FROM AGRICULTURAL MATERIAL

There are a number of possibilities for converting agricultural products or wastes to liquid fuels. The choice of raw materials and processes is complex and involves a number of important policy choices. Only recently have we had real incentives to pursue such activities, so many of the economic and technical questions still remain unanswered. There are also a number of political issues remaining to be solved as well. The intent of this publication is to present facts, to identify some of the issues and to raise some important economic and technical questions that need to be asked to better understand the actual potential of those solutions.

This publication first provides some definitions of common terms and a set of conversion factors that are useful in looking at different alcohol production processes. It then looks at the production of grain alcohol for blending with gasoline to make gasohol. Finally, it looks at the cellulose conversion alternative of utilizing agricultural by-products (such as corn stalks, cellulose wastes and old newpapers) to make ethanol.

The economic and technical issues in the cellulose converion process are sufficiently different from grain conversion to warrant an entirely separate discussion. Cellulose conversion technology may be available to us on a commercial scale within a few years. The construction of grain conversion capacity should be considered in the context of moving to cellulose conversion technology down the road.

DEFINITIONS AND CONVERSION RATIOS

Alcohols: A group of organic chemical compounds composed of carbon, hydrogen and oxygen.

Methanol (methyl alcohol, also known as wood alcohol): CH_3OH, one of the alcohols which has been proposed for blending with gasoline. However, methanol gasoline blends are more corrosive than ethanol blends.

Ethanol (ethyl alcohol): C_2H_5OH, the alcohol product of grain fermentation used in alcoholic beverages and for industrial purposes. It is proposed for blending with gasoline to make gasohol. At present, industrial ethanol is primarily produced from petroleum.

Gasohol: A blend of gasoline and alcohol (usually ethanol), commonly discussed as a product composed of 90 percent gasoline and 10 percent ethanol by volume.

Proof: Alcoholic concentration indicated by a number that is twice the percent by volume of alcohol present. Industrial ethanol is usually 190 proof (95% alcohol), and ethanol for gasohol is 200 proof (100% alcohol). Volume and weight percent are not equivalent.

Distillers Grain: A by-product of the grain fermentation process which may be used as a high protein animal feed.

Cellulose: A sugar polymer found in the woody parts of plants (e.g., corn stalks).

Fermentable Sugar: Sugar (usually glucose) derived from starch and cellulose which can be converted easily to alcohol.

Conversion Ratios

- 1 barrel equals 42 gallons.
- 1 bushel of corn weighs 56 pounds.
- 1 gallon of ethanol @ 200 proof weighs 6.6 pounds at room temperature.
- 1 gallon of ethanol contains 85,000 BTUs @ 200 proof.
- 1 gallon of No. 2 diesel fuel contains 140,000 BTUs.
- 1 gallon of gasoline contains 124,000 BTUs.
- 1 ton of crop residue contains the potential for 0.8 ton of fermentable sugar.
- 1 ton of fermentable sugar can yield up to 0.5 ton of 200 proof ethanol.

In the production of grain alcohol:

- 1 bushel of corn yields up to 2.57 gallons of 200 proof ethanol.
- 1 bushel of corn yields 16.3 pounds of carbon dioxide.
- 1 bushel of corn yields almost 17 pounds (when dried) of distillers grain at 27% protein.

GRAIN FERMENTATION FOR GASOHOL

There is much publicity currently about gasohol. Actually, gasohol is not a new concept or product. In 1934, Hiram-Walker marketed a motor fuel product called Alcolene, which was a blend of alcohol and gasoline. Since the early 1930s, the relative price of gasoline fell because of inexpensive petroleum supplies, and blending alcohol with gasoline became unprofitable. This is now changing.

On the agricultural side, with the record corn crops and with export embargos from time to time, we can face the prospect of occasional surpluses and falling grain prices. Government is continually conscious of the need to increase farm income or at least keep it from falling too far.

Gasohol emerges as an apparently attractive solution to both the agricultural and energy problems. Utilizing corn to produce alcohol can help stabilize grain prices by countering the effects of embargos and record yields. Federal subsidies for alcohol production would reduce the need for direct government programs to increase grain prices. In terms of energy, the alcohol supply would be blended on a 10 to 20 percent basis with gasoline, thereby reducing our need to import as much oil from abroad.

Some Economic Considerations

Why not have a plan which solves the agricultural surplus problem and aids in reducing our energy imports? Why haven't we implemented such a plan already? There are some sound economic reasons why we haven't been committing ourselves to large scale alcohol production until recently.

Table 1 illustrates what the economics of gasohol were in the beginning of 1978. In this example, ethanol could be produced for about $1.00 a gallon, which was 2 1/2 to 3 times the refinery price of gasoline.

In order to make gasohol production economical, therefore, the federal tax of $.04 per gallon was exempted on all gasohol sold. Since one gallon of ethanol was mixed with nine gallons of gasoline to make ten gallons of gasohol, and since each gallon of gasohol received the $.04 tax break, this is equivalent to a $.40 subsidy per gallon of alcohol.

This meant that if the refinery price of gasoline rose to within $.40 of the cost of alcohol, gasohol would be an economical proposition with the federal tax subsidy. This had not occurred in 1978, so a number of states removed their road taxes to give further subsidy to gasohol.

In early 1980 when President Carter announced his gasohol program, the refinery price of gasoline was around $.90 a gallon. Table 2 shows how the economics of gasohol

Table 1. Price Comparison for Gasoline and Gasohol, January 1978.

Item	Gasoline	Gasohol*
Gasoline @ $.38/gal at refinery	.38	.34
Ethanol @ $1.00/gal at refinery	—	.10
Transportation	.03	.03
Station mark-up	.09	.09
State tax	.06	.08
Federal tax	.04	.04
Pump price of product	.62	.68

* A mixture containing 90 percent gasoline and 10 percent ethanol.

Table 2. Price Comparison for Gasoline and Gasohol, January 1980 (Indiana).

Item	Gasoline	Gasohol*
Gasoline @ $.90/gal at refinery	.90	.81
Ethanol @ $1.60/gal at refinery**	—	.16
Transportation and handling	.04	.05
Station mark-up	.10	.10
State tax	.08	.04
Federal tax	.04	—
Pump price of product	1.16	1.16

* A mixture containing 90 percent gasoline and 10 percent ethanol.
** Ethanol was selling for $1.60/gal. because of high demand. Its cost of production was probably around $1.20/gal.

looked then, after the rapid increases in OPEC oil prices. It is clear from this table that the remission of the $.04 federal tax is by itself almost sufficient to make gasohol prices competitive, especially if one expects the refinery price of gasoline to be well over $1.00 by mid-1980. When the refinery price gets over $1.25 in this example, the remission of the Indiana state sales tax is no longer necessary to make gasohol price competitive with gasoline, even with $1.60 ethanol.

Assuming the use of gasohol nationwide, the federal subsidy is still substantial. We consume about 110 billion gallons of gasoline annually. If $.04 tax is exempted from each gallon, the total value of this subsidy is $4.4 billion or $20.00 for each person in the country.

Another important question is, "How much grain would be required to produce the ethanol needed to make a 10 percent alcohol-90 percent gasoline blend for the nation's consumption?" To make the 11 billion gallons of alcohol required, it would take 4.3 billion bushels of corn, about 60 percent of the nation's corn crop. This would require a drastic change in our livestock industry and eliminate most exports of corn. The long term question is, "To what extent are we willing to expand our ethanol production industry with just grain as a base for this expansion?" It is here that the potential for cellulose conversion to alcohol becomes critically important.

It is also helpful to examine the breakdown of the cost of production for corn fermentation ethanol. Table 3 provides the cost breakdown for a range of corn prices from $1.50 to $4.00 per bushel. The total cost of production of corn fermentation alcohol (plant, fuel, labor, interest, etc.) is about $1.62 per gallon with corn at $2.50 a bushel, including capital recovery. Credits for by-products such as dried distillers grain (DDG) amount to $.39 per gallon. (All calculations are done for a plant producing 50 million gallons of ethanol annually.)

Note that the value of DDG may be on the high side if nearby markets are not available or if by-product prices should fall with increasing output. It may be on the low side if DDG prices rise with corn prices.

The annual corn requirement for the plant is 19.5 million bushels. As can be seen from Table 3, ethanol corn price combinations range from $1.50 corn yielding $.93 ethanol to $4.00 corn yielding $1.63 ethanol. The alcohol price for $2.50 corn is $1.21 per gallon.

The Question of Energy Efficiency

Another consideration that has created considerable interest is the net energy ef-

Table 3. Cost of Producing Alcohol from Corn.*

Corn price	Corn cost[a]	Fixed costs[b]	Operating costs[c]	Gross total cost	By-product credits[d]	Minimum alcohol selling price[e]
$/bu.	$/gal.	$/gal.	$/gal.	$/gal.	$/gal.	$/gal.
1.50	.58	.31	.31	1.20	.27	.53
2.00	.78	.31	.31	1.40	.33	1.07
2.50	.97	.31	.31	1.59	.38	1.21
3.00	1.17	.31	.31	1.79	.44	1.35
3.50	1.36	.31	.31	1.98	.49	1.49
4.00	1.56	.31	.31	2.18	.55	1.63

SOURCE: the raw data for compiling this table were obtained from Grain Motor Fuel Alcohol-Technical and Economic Assessment Study, prepared for the U.S. Department of Energy by Raphael Katzen Associates (June 1979).

* The data were coverted to first quarter 1980 costs. Plant size is 50 million gallons per year. The plant uses coal for processing energy.

a/ This conversion assumes 2.57 gallons of alcohol is produced from one bushel of corn.

b/ The fixed costs include amortization of the investment costs over 15 years at 15 percent rate of return plus license fees, maintenance, tax, and insurance. The capital cost including working capital is $73.14 million.

c/ Operating costs include row materials other than corn, such as energy, labor, overhead, freight and miscellaneous expenses.

d/ The by-products are distillers grains and ammonium sulfate. Distillers grains are valued at $110 per dry ton and contribute 37 of the 38 cents by-product credit at $2.50 corn. The distillers grain by-product credit in this table is calculated assuming that protein prices change along with corn prices. We assumed that three-fourths of the proportional change in corn prices occurs in DDG prices. For example, the change in corn price from $2.50 to $3.50 represents a 40 percent increase in corn prices, and we assume a DDG price of $143, which is 30 percent higher than the $110 base price.

The two prices tend to move in the same direction because corn and soybeans (a protein source) are grown in the same areas on the same type of land. However, the exact relationship between the two prices is not known, and this assumption represents our judgement as to what the relationship might be.

e/ This price includes profit for the producer (in the capital recovery component of fixed costs).

ficiency of the corn to ethanol conversion process. Does the process consume more energy than it actually produces? The answer to this question is unclear, and "creative accounting" or changes in assumptions can shift the results of the analysis from one conclusion to another. However, a number of large engineering firms claim to have energy efficient processes.

The results depend critically upon the assumptions made regarding: (1) the inclusion of crop residues in the analysis, (2) the processing or drying of by-products, (3) the vintage of technology used, (4) the efficiency of alcohol utilization in automobiles and (5) changes in the petroleum refining process which might be possible if alcohol could be used widely as an octane booster.

Most recent studies indicate that with new but currently available technology, the net energy output of alcohol used for gasohol balances or is perhaps somewhat greater than the input energy in growing, transporting and processing the corn into alcohol.**

However, analyzing net energy may really ignore the most important factor that will influence national energy policy in the coming years. This is the need for liquid fuels, not just for net energy. It may not matter if ethanol production requires the same amount of energy, or even a bit more energy than is returned in the liquid product. Instead, the critical factor is whether we design our alcohol production capacity to run on solid energy forms like coal, which we have in abundance, rather than on oil or gas.

If federal subsidies encouraged the use of coal, the production of ethanol might be

** Two good sources for further information are: R. S. Chambers, K. A. Herendeen, J. J. Joyce and P. S. Penner, "Gasohol: Does It or Doesn't It Produce Net Energy," Science, Vol. 206, No. 4420 (Nov. 16, 1979); and Office of Technology Assessment, U.S. Congress, Gasohol: A Technical Memorandum, O.T.A., Washington, D.C., Sept. 1979.

viewed as an indirect way of converting coal to a liquid fuel. In our judgment, the federal subsidies should be denied to plants that burn oil or gas in the ethanol production process.

Some Policy Issues Involved

Beyond the complex issues discussed above lies an even more complex set of social policy issues dealing with energy and agriculture. We must strive to answer such questions as the following:

1. Many economists consider the cost to society of oil imports to be considerably higher than the private costs. How valuable is it to society to produce energy at home rather than to import it; and what is the best means to accomplish that objective?

2. What are the feedback costs of higher oil prices that go into the cost of producing corn and converting it to ethanol? Gasohol does not necessarily become economical when gasoline refinery prices reach over $1.25 per gallon--because the cost of corn energy inputs in turn rise in price; thus, energy input costs in the conversion process rise in price.

3. What effects would various sizes of gasohol programs have on agriculture (in terms of corn and soybean prices, exports and farm incomes)?

4. What might be the consequences of alternative policies designed to stimulate production of energy from agriculture?

These and other questions remain unanswered, but research continues to focus on reaching answers.

FERMENTATION OF AGRICULTURAL BY-PRODUCTS INTO ALCOHOL

We now shift our focus to the use of agricultural by-products as input materials. The prospect of using agricultural by-products and other cellulosic residue materials to produce fuels such as ethanol and chemicals for industry holds some promise if the research and economics can be worked out. By cellulosic residues we mean corn stalks, sugar cane bagasse, waste paper and other municipal wastes and forestry products.

Presently, the United States produces approximately one billion tons of cellulosic waste materials each year, which theoretically could sustitute for a large percentage of our liquid fuel needs. However, the question is not only availability of cellulose materials, but also collectibility, conversion and the alternative value of these materials.

Of the approximately 400 million tons of agricultural crop residues produced each year, it is estimated that about 80 million tons should and could be removed from farm land for conversion to alcohol. This quantity of residue could potentially produce as much as 9.7 billion gallons of alcohol, about the same amount that could be produced from 50 percent of our corn crop.

Cellulose Conversion

Generally, cellulosic wastes contain three main components--hemicellulose, cellulose and lignin. Lignin is basically the cementing material of trees and other woody parts of the plant. Current residue utilization processes have had a very difficult time separating the protective lignin seal from the cellulose. Once made accessible, the cellusose can be used to produce alcohol by the traditional fermentation processes.

Several new processes for cellulose conversion are under development in the U.S. One of these is in the Laboratory of Renewable Resources Engineering (LORRE) at Purdue University under the direction of Dr. George T. Tsao. On a laboratory basis, the various approaches under development can convert one ton of cellulose into 0.8 ton of fermentable sugar. This involves converting each of the components of the cellulosic wastes into fermentable sugars and then into alcohols. Hemicellulose is converted to sugar first, and then the residual cellulosic material is pretreated and subsequently converted.

When comparing corn grain to corn crop residues, one ton of corn grain (35.7 bushels) can produce 0.65 ton of fermentable sugar from the starch portion. Using LORRE technology, 0.15 ton of fermentable sugar can be converted from the fiber in the grain, giving a total of 0.8 ton of fermentable sugar which is converted into 0.4 ton (120 gallons) of alcohol.

On the other hand, one ton of corn crop residue contains about 0.8 ton of fermentable sugar, which has a maximum potential yield of 0.4 ton (120 gallons) of alcohol. Potentially, as much alcohol could be produced from one ton of cellulosic wastes as can be produced from one ton of grain when using these new processes to convert cellulose into alcohol.

Crop Residue Harvesting and Handling

Another question to be answered involves removal of the crop residue from the field. To what extent does residue effect soil fertility and tilth? Research indicates that some cropland erodes badly enough so that no residue should be removed.

Crop residue removal also competes with harvesting and subsequent fall tillage. Therefore, more work must be done in identifying the optimum level of corn residue removal. A farmer with an opportunity cost of $600 per hour for harvesting his grain is not likely to harvest crop residues at the rate of $60-70 an hour if the grain and residue are competing for time. Equipment must be developed that can collect the waste material easily without interfering with the harvesting practice.

Yet another important problem is handling the residue. A profitable processing plant runs the entire year and therefore must have a continuous supply of crop residues. Crop residues will have to be handled very much like our grain or forage products are presently. That is, they must be collected and stored either as a dry or ensiled product in a system economically able to maintain quality and access for future transportation and processing. The transportation will have to be optimized in terms of how far it is economically feasible to transport these products. Many questions must be answered before we can proceed into the waste cellulose process.

Other sources of cellulosic waste materials include forest residues and municipal and industrial waste products. Although we may have a more constant supply of these products throughout the year to feed to a processing plant, the same questions concerning the economic feasibility, handling systems and equipment must be answered to design an efficient process.

Several other useful and high-priced products can also be made from grains and waste materials. Planning for research regarding utilization of waste materials and grains should include not only ethanol but also other chemicals. However, many technical and economic questions remain unanswered and constitute a major part of our current research efforts.

Alcohol Fermentation

Using sugars derived from starch or cellulose, the maximum yield is 1 pound of ethyl alcohol from each 2 pounds of fermentable sugar. The other half of the weight of sugar is given off as carbon dioxide.

It is desirable to obtain a concentration of ethanol in the fermentation broth of at least 6 percent. Below this concentration, the separation of ethanol from water by distillation becomes very energy-intensive. Current fermentation technology is capable of attaining up to 12 percent ethanol concentration in a reasonable fermentation time.

CONCLUSION

The heightened interest and activity in alcohol production for energy purposes is taking place in an environment where problems are looming larger and we are being pressed by world events for solutions to complex technical problems. Any new technology like cellulose conversion must go through a number of steps before it is applicable to full-scale commercialization and utilization. Even with the technology available, as in the case of alcohol production from corn, it takes substantial time and effort to capitalize and construct a new industry.

Our tendency is to want immediate "solutions" and to either accept or reject them on the first round of results. Uncritical acceptance based on positive results, or the equally likely rejection based on a first round of failures, does not give a technology the necessary time to develop and be proven. Either approach is likely to cause more harm than good. What is needed is less pressure for instant solutions and more patience for testing both new technologies that appear to work and those that still have to overcome many problems.

Mr. FITHIAN. Dr. Peart?

Dr. PEART. I will summarize my statement.

A group of us in the School of Agriculture at Purdue, interdisciplinary group, completed a study in 1977, funded by the National Science Foundation; and we studied in detail the energy requirements for raising corn, producing corn. The results of that are shown on page 2, in detail, as far as what goes into fuel for the field machinery, the fertilizers, pesticides and the fuel for drying corn that's raised in the Corn Belt. Then we calculated the outputs, the yield, as it varies from year to year, using weather data, and have summarized that in table 2 on the basis of obtaining 2.6 gallons of ethanol per bushel of corn. To summarize, our totals come out that about 23,000 Btu's of energy go into the raising of the corn grain for each gallon of ethanol. That's charging all of that energy to the grain itself and not charging any of it to the protein byproduct, the distiller's grain, or to the residue, so that those byproducts are essentially free as far as energy is concerned.

We disagree with the accuracy of the data in that ERAB report. It was based on Dr. Pimentel's early article in Science magazine on the energy use in corn production, and it showed higher figures for the energy input than what our research showed. That's a disagreement we have with the accuracy of those numbers, and there are several reasons for that, that we give in the testimony there.

In addition, the point that's made in this report by Dr. Doering and Dr. Tyner on alcohol production is that the form of that energy is important and the liquid fuel is what we are really critically short of. Many of the inputs into corn production come from natural gas, and that economics are that that energy is much less expensive than energy from liquid oil, diesel fuel, and gasoline. So, that makes the economics of alcohol production look better than the strict energy accounting of it, and I think that's the second major point that we wanted to make.

Another agricultural economist at the University of Illinois has made some interesting calculations recently. This is Dr. Folke Dovring, and I quote him in the report, saying that the export price of a bushel of corn ought to exceed one-tenth of the import price of a barrel of crude oil; otherwise, it would be more economical to produce ethanol from the grain, export the distiller's grain byproduct instead of the corn, and thereby replace the imported oil with ethanol. In other words, if crude oil on the spot market is, say, $35 a barrel, his analysis would suggest that we should not export corn unless we would get one-tenth of that, or $3.50 per bushel, for the corn, just on a strict economic basis that that corn would produce enough ethanol to replace the fuel from the imported barrel of oil at $35.

That summarizes my testimony.

Mr. FITHIAN. Thank you, Dr. Peart.

[Dr. Peart's prepared statement follows:]

Testimony of Robert M. Peart, Professor of Agricultural Engineering
Purdue University, W. Lafayette, IN 47907
and Research Program Leader, USDA-SEA
Northern Energy Center, Peoria, Illinois

Before U.S. House of Representatives, Sub Committee on the
Environment, Energy and Natural Resources of the
Government Operations Committee

July 28, 1980 - Lafayette, Indiana

Energy for Corn Production for Fuel Ethanol

The energy efficiency of ethanol production from corn grain has been questioned recently. A significant amount of energy is used in grain production, and we have studied this in detail. The following interdisciplinary group worked on a National Science Foundation study in 1977 (summary of report attached). In addition, other faculty, a post doctoral fellow and several graduate students worked on the project, and industry and farm representatives met with us and had input.

Dr. Otto C. Doering III, Agricultural Economics - Project Leader
Dr. Stanley Barber, Agronomy
Dr. Robert Pickett, Agronomy
Dr. Robert F. Dale, Agronomy
Dr. Carl Noller, Animal Sciences
Dr. Samuel Parsons, Agricultural Engineering
Dr. Robert Peart, Agricultural Engineering

The unique feature of our study was the consideration of actual weather and its effect on timeliness of operations and yield. We calculated the amount and type of energy input for each field operation, for transport from field to farmstead, for utility transport to and from fields, crop drying fuel, and the energy inputs into the manufacture and transport of all fertilizers, herbicides and insecticides. We did not calculate energy inputs into seed production and machinery manufacture, but separate work indicates that these represent less than 10% of the inputs to Midwest corn production. Likewise, we did not include irrigation, but it is a major input where it is used. I estimate that about 15% of U.S. corn production is irrigated.

Weather input was especially important in our calculation of corn yields, and realistic yields for level, productive western central Indiana typical of much of the Corn Belt were obtained. We did the calculations for 7 years of weather at Lafayette, 1968-74. The low yield due to the dry weather of 1974 was included, but the corn leaf blight of 1970 was not.

Input and output results averaged over these 7 years are shown in Table 1.

Table 1. Energy Inputs and Outputs in Midwest, Non-irrigated Production of Corn, conventional tillage, level, productive soil.

INPUTS	Amt. per acre	Energy Equivalent, Million/Btu Acre
Fuel for field machinery, diesel	9.0 gal/acre	1.22
Fertilizers, Nitrogen	175 lb/acre	4.38
Phosphorus & Potassium	128 lb/acre	0.32
Pesticides, including herbicides	5 lb active ingred/acre	0.60
Fuel for drying of grain, LP gas	20.7 gal/acre	1.93
TOTAL		8.45

OUTPUTS:		
Grain, shelled corn	138.7 bu/acre	54.37*
Residue, all above-ground	3.9 tons/acre	54.37*
Corn cobs (included in residue above)	1380 lb/acre	9.71*
TOTAL		108.74

Grain Output/Direct Energy Input = 6.43
*7000 Btu/pound @ 15 1/2% moisture wet basis

The energy output/input ratio is the key information, and it shows the blessing of photosynthesis and solar energy which convert these inputs into six times as much energy in the corn kernels alone. In addition, the cobs contain energy equivalent to about 15% of that in the grain. All of the above-ground residue, stalks, leaves and cobs, contain energy about equivalent to that in the grain. So the entire corn plant returns about 12 times the fossil energy inputs.

The inputs to corn production are mostly gaseous, not liquid. Drying fuel is LP gas or natural gas, and the major fertilizer input, nitrogen, is produced from natural gas. Electrical inputs for drying fans and conveying equipment are so small we did not include them. The crop production energy inputs are reported in terms of the potential ethanol production in Table 2.

Table 2. Approximate Corn Production Energy Inputs per Gallon of Ethanol Produced.

(Level, productive soil, 140 bu/acre, 2.6 gal. ethanol/bu)

Input	Main Source	Input Energy
Chemical fertilizers and pesticides	Natural gas	15,000 Btu/gallon ethanol
Grain drying	LP and natural gas	5,0 Btu/gallon ethanol
Field equipment	Diesel oil	3,000 Btu/gavlon ethanol
Total		23,000 Btu/gallon ethanol

A major data source for many studies of ethanol energy balances has been Pimentel's early Science article (2). We credit this work in calling attention to a valuable method of analysis, but we disagree with the values obtained. His results show less than half the Corn Belt energy efficiencies we calculated. A major cause is his use of 1970 U.S. average yields which were low due to the corn leaf blight. We used weather-based yields on high-fertility soil and these yields are higher than the U.S. average. Pimentel's workers calculated the energy input for manufactoring the farm equipment and then allocated this to 62 acres of corn. We feel the equipment is used on much more corn, perhaps an average of 400 acres in the Corn Belt. They also estimated a relatively high electrical energy use to corn in proportion to its acreage.

These energy estimates of Pimentel, et al., were used in the analysis of Weisz and Marshall (3) in another Science article, and they concluded that ethanol from grain produces no new net energy (as did the ERAB report). Our Corn Belt values would change their results markedly by reducing the energy inputs to ethanol production by about 30,000 Btu/gallon of ethanol. Ethanol itself contains about 84,500 Btu/gallon, so this correction is significant. It is important to note that the analysis in the ERAB Gasohol Report charges all the energy inputs to the ethanol, leaving the distillers grain and crop residue free of any energy input charge.

Probably more significant than the actual energy accounting, however, is the form and utility of the various energy inputs and outputs. Ethanol is a liquid fuel that replaces gasoline from imported oil on about a gallon-for-gallon basis. (Auto mileage with gasohol is about equal to that with unleaded gasoline in spite of the slightly lower energy content.) The only liquid fuel input to corn production is diesel fuel and a lesser amount of gasoline. Natural and LP gases are petroleum products, but our dependence on imports of gas is minor, and the cost per Btu is considerably less than that of liquid fuels. Cost is probably the best measure of the utility and relative scarcity of particular energy forms, and the cost of natural gas is several times less than the cost of liquid fuels such as gasoline and diesel fuel.

The economic argument in favor of converting corn to ethanol is even more telling when imported oil costs rather than average oil costs are considered. Dovring (4) has recently shown that from the economic viewpoint, "the export price of a bushel of corn ought to exceed 1/10 of the import price of a barrel of crude oil", otherwise it would be more economic to produce ethanol from the grain, export the distiller's grain and replace the imported oil with ethanol. Thus with crude oil on the spot market at $35. a barrel, the equivalent corn price should be $3.50 per bushel, according to Dr. Dovring.

The ERAB Gasohol report concludes that grain ethanol from oil or gas-fueled distilleries produces no new net energy. We believe first that with distillation and fermentation technology, their conclusion is inaccurate, and more importantly that the liquid form of ethanol replacing critical and expensive imported oil justifies high inputs of other energy forms. Other factors include the advantages of more U.S. jobs with U.S. ethanol production, the continuing improvements in corn and ethanol production efficiency with biomass-fueled and solar drying and better use of manure to replace some fertilizers, and the future possibilities of converting ethanol plants to

cellulosic raw materials for feedstock and heat sources.

There is a great deal of misinformation about the environmental impact of utilizing biomass for energy. We certainly do have environmental problems today in agriculture - there are some thirty million acres of fragile lands being cropped today which should probably be returned to grasslands or some other less intensive use. However, given the proper institutional and economic incentives we can greatly improve those specific cases where intensive cropping is causing substantial losses of topsoil or nutrients. In addition, once cellulose conversion technology goes to commercial scale we can utilize materials like hay to make scarce liquid fuels. Grass is one of our best crops for rebuilding soil structure and preventing erosion on land that would suffer degradation under intensive row crop cultivation. The ability to use this crop for energy production means that we can create a market for hay crops that will allow this land to yield an economic return when otherwise a farmer might have been tempted to let it erode for short term gain in the cultivation of row crops like corn.

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Mr. FITHIAN. Dr. Ladisch?

STATEMENT OF DR. MICHAEL R. LADISCH, ASSISTANT PROFESSOR OF AGRICULTURAL ENGINEERING, PURDUE UNIVERSITY

Dr. LADISCH. Congressman Fithian, I am Michael Ladisch, also from Purdue University, and I'd just like to very briefly summarize the points that I have made in the statement which has been submitted for the record. This statement is just a summary of research and development results which have begun to gel within the last 4 to 6 months, and we are really excited about it. Just real briefly, I'd like to point out that I'll be using the words "hemicellulose" and "cellulose" throughout this statement; and the terms "hemicellulose" and "cellulose" refer to polymers of sugar which are broken down.

Hemicellulose is a polymer of five carbon sugars, and you can think of it as a chain. When this is broken down, it gives a sugar which until recently has not been easily fermented into ethanol. Cellulose, on the other hand, is a polymer of six carbon glucose sugars; and the problem with this polymer has been that it is difficult to break down, but once it gets to sugar, it's pretty easy to ferment.

Basically, there are three major developments that have occurred recently. One is the discovery of fermentation conditions which allow the direct conversion of xylose to ethanol using ordinary yeast. The second is the development of an energy-efficient method for removing water from alcohol using partial distillation combined with adsorption using cornmeal as an adsorbent. The third is the development of reaction conditions which allow hydrolysis of both hemicellulose and cellulose fiber components of biomass at the relatively mild conditions of 100° C and atmospheric pressure.

And I would like to point out that although these results may seem obvious in hindsight, they caught us by surprise. One of the implications is that existing corn grain plants which are using acid hydrolysis processes may, with some further reasearch and development, be retrofitted to convert fiber, corn residue, for big city trash or these types of materials, using the sort of process conditions that we are developing now. I should caution, there's still a lot of research and development down the road before this becomes a reality.

The use of yeast to ferment xylose was discovered by Drs. C. S. Gong, L. F. Chen, M. C. Flickinger, and G. T. Tsao; and this makes it possible to convert sugars derived from the hemicellulose constituent of biomass to ethanol. The reason this is significant is that hemicellulose is very readily converted to these fermentable sugars; and once you have a way of fermenting these to ethanol, you then have the possibility of not only converting most of the biomass to ethanol, but also of converting the fiber component in corn grain to ethanol. The fiber component of corn grain is primarily hemicellulose, and so it has been estimated, based on some of the preliminary results of people I have just mentioned, that the yield of ethanol from grain can be increased from 10 to 20 percent if the fiber component of the grain is hydrolyzed to fermentable sugars and then fermented to ethanol.

Basically the bottom line is that it means you could get anywhere from 2.8 to perhaps as high as 3 gallons of ethanol per bushel of corn,

whereas presently the maximum theoretical yield is about 2.5 gallons. That means you can perhaps look at increasing ethanol yields, using this manner.

Another important area is the removal of water from ethanol in an energy-efficient manner. Prior distillation processes, which consume about 25 to 50 percent of the energy of a typical fermentation facility, involve basically two steps: fractionation of the fermented dilute alcohol solution to the azeotrope, and then redistillation with an extractant or an azeotroping agent. Rather than go into details, I will just give you the result; that is, that a disproportionate amount of energy is consumed going from the more dilute alcohol—that is a 92-percent alcohol—from the azeotrope.

So what we have done is to substitute, at the final part of the distillation step, which is very energy-intensive, a simple adsorption step; that is, we take the vapors off our first distillation column, which is pretty energy efficient, and then take these vapors and pass them over ground-up cornmeal or materials such as corn stover or cellulosic materials. Due to their properties, these materials suck up the water, so to speak, and allow anhydrous alcohol to pass. We estimate, based on laboratory data, that the combination of distillation with adsorption in the manner just described reduces the overall energy for distilling alcohol to a pure product to about 10 to 15 percent of the energy of the final product, which we believe is pretty low and will help the energy balance in the overall plan.

Finally, research on hemicellulose and cellulose hydrolysis to sugars * * * both the laboratory and research pilot plant scale indicate high conversions of both these components to sugars as possible at about 100° C, 212° F, using relatively small quantities of acid. That means we can now use a catalyst which is commercially available, sulfuric acid, at conditions that are rather mild; and we hope to carry this up through the scale-up phases. This is a very important step, because now we feel that reactors can be made without having to resort to very expensive metals, and so forth; and this has impact both on biomass conversion as well as grain conversion.

I would like to sum up this statement by saying the research described in this report gives examples of recent developments in ethanol technology and how this technology is not fixed. It's really changing very rapidly. For example, I think someone asked me 6 months ago, "Do you think grain plants could be retrofitted to convert biomass?" I told this person, who was an Indiana businessman, that absolutely not; I didn't believe this could be done and therefore you should be careful not to mix the two together.

But as I sit here today, due to the research results which have just come about in the last 4 months, I am now taking a different opinion. This just gives you an idea of how quickly this energy field is moving. Therefore, I personally feel that varying perceptions of alcohol technology in the future may result due to the rapidly changing character of the alcohol research.

I would like to make an acknowledgment. These results and other research in related areas at Purdue University are supported by various sources. These include the State of Indiana, which has been very generous in allowing us the funds to build a pilot plant facility

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which we believe is to be one of a kind in the country; the U.S. Department of Energy, including SERI; the U.S. Department of Agriculture; the National Science Foundation; and various industrial sources.

I thank you very much, Congressman Fithian.

Mr. FITHIAN. Thank you.

[Dr. Ladisch's prepared statement follows:]

RECENT DEVELOPMENTS IN BIOMASS CONVERSION RESEARCH

by

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Introduction

This statement is a summary of developments which have begun to gel within the last four to six months as part of the on-going research program in biomass conversion at Purdue University. These developments have the potential of adding to the continually changing perspective of producing ethanol from biomass and grains.

The terms hemicellulose and cellulose will be used frequently throughout this statement. Hemicellulose and cellulose are both polymers of sugars. A polymer can be thought of as a chain, and in this case, each link in the chain is a sugar molecule. Hydrolysis of a polymer is analogous to separating links in the chain into individual units. The sugars which result are converted into alcohol by micro-organisms by a process referred to as fermentation.

Hemicellulose is a polymer of five carbon sugars (pentoses). When this chain of pentoses is broken down into individual units the primary sugar obtained is xylose. While this hydrolysis is relatively "easy," in the past the xylose sugar which resulted has not been readily fermented into ethanol.

Hence, hemicellulose, which makes up 25% to 35% of the weight of biomass materials such as corn stover, wheat straw, sawdust, and the organic portion of big city trash, could not be effectively utilized.

Cellulose, in comparison, is a chain of glucose (grape sugar) units. This polymer makes up 30% to 50% of biomass materials. Cellulose has been much more difficult to hydrolyze than hemicellulose in the past. The glucose which resulted from hydrolysis can be readily fermented to ethanol by time honored methods. However, the yield obtained was somewhat low due to the difficulty in converting cellulose to glucose.

Keeping this background in mind, recent developments are discussed below.

Summary

Research on conversion of biomass to liquid fuels and chemicals has very recently resulted in new developments which have the potential of improving the efficiency of producing alcohol from biomass. This research also has some bearing on improving the conversion of grain to alcohol. The developments referred to are: 1) the discovery of fermentation conditions which allow the direct conversion of xylose to ethanol using ordinary yeast; 2) the development of an energy-efficient method for removing water from alcohol using partial distillation combined with adsorption using cornmeal as the adsorbent; and 3) development of reaction conditions which allow hydrolysis of both the hemicellulose and cellulose fiber components of biomass at the relatively mild conditions of 100°C and atmospheric pressure.

The use of yeast to ferment xylose to ethanol was discovered by Drs. C. S. Gong, L. F. Chen, M. C. Flickinger, and G. T. Tsao. This makes it possible to convert sugars derived from the hemicellulose constituent of

biomass to ethanol. Hemicellulose is readily hydrolyzed to fermentable five-carbon sugars. The problem in the past has been to find and develop special micro-organisms to convert these sugars to ethanol.

Many years ago only the glucose (obtained from hydrolysis of the cellulose component) could be fermented to ethanol. Hence, the yield of ethanol from biomass was less than 50% of what could be theoretically be obtained if the fermentable sugars from both hemicellulose and cellulose portions of biomass are considered. With the development of special micro-organisms, the ethanol yield is higher since fermentable sugars from hemicellulose could be utilized. However, use of these micro-organisms requires an extra measure of sophistication which includes the maintenance of cultures, and generation of sufficient quantitites of these cultures to be generally available for large-scale use.

The discovery that fermentation conditions can be changed using commercially available biological factors together with ordinary yeast to produce ethanol from hemicellulose derived sugars has changed this. Yeast is widely available and relatively inexpensive. The fact that large quantities of yeast cake can be added to a fermentor to quickly start-off the fermentation means that, with further research and development, hemicellulose sugars can be produced into alcohol in both large and small scale alcohol production facilities.

This method also has significance to the conversion of corn to alcohol. The fiber component of corn (grain) is primarily hemicellulose. It has been estimated that the yield of ethanol from grain can be increased from 10% to 20% if the fiber component of the grain is hydrolyzed to fermentable sugars at mild conditions with acid and then fermented to alcohol. This could

increase the yield of ethanol from a bushel of corn to as high as 2.8 to 3 gallons. The current maximum theoretical yield based only on the starch component of corn is 2.5 gallons.

The removal of water from ethanol in an energy efficient manner is an important step for production of anhydrous ethanol. Prior distillation processes, which consume about 25% to 50% of the energy of a typical fermentation facility, involve two steps: fractionation of the fermented dilute alcohol solution to the azeotrope (95.6% ethanol by weight) and redistillation with an extractant or an azeotroping agent. It has been shown that a disproportionate amount of energy is consumed going from 92% ethanol to the azeotrope in the first distillation step. Research is underway on the use of cornmeal to selectively absorb water from ethanol/water vapors to produce anhydrous ethanol from 92% (or lower) alcohol. This approach avoids the second distillation step altogether and reduces the overall energy for alcohol recovery to 10% to 15% of the energy contained in the pure ethanol.

Research on hemicellulose and cellulose hydrolysis to sugars on both the laboratory and research pilot plant scale indicates high conversions of both these components to sugars is possible at 100°C (212°F) using relatively small quantitites of sulfuric acid. The temperature of hydrolysis is comparable to that used for starch hydrolysis currently carried out for grain conversion to alcohol. This relatively low temperature of hydrolysis is significant since further hydrolysis research and development may yield results which would make it possible to retrofit some types of corn (grain) acid hydrolysis reactors to convert cellulosic residues to sugars as well. Fermentation and distillation process conditions for sugars derived from either grain or biomass are also comparable when other recent developments mentioned in this statement are considered.

The research described in this report gives examples of recent developments in ethanol technology and how this technology is not fixed. Varying perceptions of alcohol technology in the future may result due to the rapidly changing character of alcohol research.

These results and other research in related areas at Purdue University is supported by various sources. These include the State of Indiana, the U. S. Department of Energy (including SERI), the U. S. Department of Agriculture, the National Science Foundation, and various industrial sources.

Mr. FITHIAN. I want to just clarify three or four points here and let you perhaps all elaborate on some of your statements.

I understand from your statement, Mr. Childress, that in the remainder of your prepared text you are satisfied that the food-versus-fuel question, which is constantly bandied about in the media and the public and even among some of the scientists who are arguing about this, is pretty well put to rest. Is that the burden of your testimony?

Mr. CHILDRESS. That is basically it. I would like to stress two points. The first is that there is not an imminent problem, no matter how anyone defines it. Early drafts of the Office of Technology Assessment report that I cited had indicated that production of as little as 1 billion gallons of ethanol would cause some inflation. Well, they are now saying 2 billion gallons, and as our knowledge evolves, the point at which some inflation may occur keeps rising.

The other point is that there are controlling factors, including Federal policy, market forces, and what the financial community is willing to invest; that will keep this from becoming a problem.

Mr. FITHIAN. Let me just do a followup question on that. As I understand your comment, professor, the breakthroughs that you have made would increase the yield from a bushel of corn.

Dr. LADISCH. Yes, sir.

Mr. FITHIAN. I think everywhere throughout DOE and the USDA and so on, 2.5 gallons per bushel has been the standard used. You are now suggesting that with this additional breakthrough in technology, that would be——

Dr. LADISCH. 2.8 gallons.

Mr. FITHIAN [continuing]. 2.8.

Dr. LADISCH. Or maybe as high as 3 gallons per bushel.

Mr. FITHIAN. So, roughing it off, 2.8 to 3.

All of your calculations then, Mr. Childress, were geared to a 2.5-gallon base. Is that correct?

Mr. CHILDRESS. Correct. They did, in this particular study, base it on 2.5.

Mr. FITHIAN. I would just like to emphasize what has just been said, and that is that the speed of development in this field makes it always a bit treacherous to start making projections. I think that we were talking about that with the DOE people earlier, that even the most accurate projection of July 1979 becomes hopelessly outdated by July 1980; and this kind of evidence would indicate that.

Mr. CHILDRESS. If I could expand upon that point, some say that this cellulosic research is simply an academic exercise and will not go beyond the laboratory stage. As a matter of fact, within the past week, I have talked to representatives of a rather large firm which is engaged in just the same research, and their initial figures coincide very closely with the Purdue figures. So this is not something that is pie in the sky. People in the private sector are putting money on the line in this area with the expectation of a payout.

Mr. FITHIAN. I would like to also ascertain—you did refer to the Schnittker report. I would like, without objection, to have that made a part of the record as material accumulated by the subcommittee. If you could submit a copy of that report, that would be very helpful.

Let me turn now to Dr. Peart. The energy balance question has really plagued us, and I can be a witness on this. I have rarely had two town meetings in a row in this part of the Corn Belt in which we don't get the question whether or not it takes more energy to make a gallon of alcohol than you get from the gallon of alcohol. I have had some scientists in the field, chemists persumably, retired chemists from Purdue in at least one case, insist that I was wrong and insist that it was a negative energy balance.

As I understood your testimony, you said two things. One was, even if it is a negative balance, you are getting liquid fuel, and that's what we are really short of; so, it's an academic—no, I shouldn't say that; it's an academic question—but if I understood what you said correctly, Dr. Peart, what you were saying is that even if you attribute or assign all the costs of the energy of raising the corn to the alcohol and assign none of it—let's say you take the wet-down process to the 60-percent protein and 22-percent protein and the germ oil, which of course are the most valuable parts of the kernel in the first place—that you would still come out with a positive energy balance. Is that what you are saying?

Dr. PEART. Yes; that would of course depend upon the energy going into the fermentation and distillation process. Dr. Ladisch is more of an expert on that, but the figures that I have heard would put it still as a net energy producer.

Mr. FITHIAN. So if it is in fact a net energy producer, without giving any economic or energy credits to the byproducts, then isn't it reasonable among anyone, in any group of people who are really trying to fashion policy, in this case, or farmers who are deciding whether to invest, or co-ops or industry deciding to invest, the company accountant would not compute in the fashion that you have? They would assign some of that cost of energy and some of the cost of dollars to the byproduct, which has a value in and of itself. Isn't that the more reasonable approach?

Dr. PEART. Yes.

Mr. DECKARD. Will the chairman yield?

Mr. FITHIAN. I'd be happy to.

Mr. DECKARD. May I ask the same type of question, but in a different way? Are you aware of any available current technology, with perhaps the exception of solar, that produces as much energy as it consumes, that is to say, assuming a 100-percent efficiency?

Dr. PEART. No, no. Your point is well made. Solar, of course, is free; but, that's right, every form of energy takes some energy to convert it into the form that we would like to use.

Mr. DECKARD. If the chairman would yield just a moment more.

Mr. FITHIAN. Yes.

Mr. DECKARD. In reading over your testimony last night, I was struck on the first page by the long paragraph which seems to me to indicate that you have bent over backward in trying to be fair about this matter of ethanol and alcohol-based fuels, taking into consideration the amount and type of energy input for each field operation, for transport from field to farmstead, for utility transport to and from fields, crop drying fuel, and the energy inputs into the manufacture and the transportation of all fertilizers, herbicides, and insecticides. In other words, you are taking into consideration all sorts of ancillary

energy costs—and by costs, I mean energy units—that are not taken into consideration in any other type of energy source. For example, when we consider the amount of energy produced from a ton of coal, for example, we don't subtract from that amount the cost of transporting, the energy cost of transporting that coal to the point of consumption; we don't take into consideration the energy cost in producing the machinery that's needed to dig that coal and the cost of transporting the raw material to build the machinery and so on and so forth.

So you have bent over backward in your calculations as to the net energy production in ethanol. I think actually it's unfair to this product to take those into consideration when they are not taken into consideration in other energy forms, and represents one of the reasons that this argument that the gasohol is not energy efficient is fallacious.

Dr. PEART. Yes, I'd agree with you.

We did this study, of course, really not thinking about the gasohol issue at the time. We were just looking at energy inputs into crop agriculture and how those could be improved. I should add that these are for current good technology; and the same is true in agriculture as is true in alcohol production, that these are being improved all the time. As energy costs increase, we are finding ways to cut down on those energy inputs.

Mr. DECKARD. I think we have probably beat to death the matter of this report, but just to ask one more question about it: Were you in your capacities, each of you, aware of that report at that time and, if so, what was your opinion at the time and your opinion now?

Mr. CHILDRESS. I was aware of the report.

Mr. DECKARD. How did you know and when did you know it?

Mr. CHILDRESS. The Alcohol Fuels Commission was not really directly involved in commenting on the report itself. Prior to its release, obviously, there are always staff conversations back and forth, but we were not directly involved. Quite frankly, after I had read the report, I was so unimpressed with it that I had assumed that those out in the technical community would dismiss it—which is, in fact, I think, pretty well how it is considered out there.

On the other hand, there is the point that was raised earlier: the negative effect the ERAB report could have on the financial community. The National Alcohol Fuels Commission held hearings in mid-June, including a full afternoon of hearings from potential financiers. Universally, they are very, very conservative to the point of being negative on alcohol fuels because they consider it an unproven, risky technology. If for no other reason than that, the ERAB report——

Mr. DECKARD. Or perhaps because of the bias toward the various high technologies.

Mr. CHILDRESS. That is correct because many believe that the high technologies can produce more at a lower price. That is debatable. The closer one gets to the production of synthetic fuels, the higher the costs seem to get. Many ask: Why deal with ethanol and methanol from biomass if you have all of these cheap coal-based synfuels coming down the road? The answer is: We don't know what they are going to cost; few independent analyses have been done, the closer to commercialization the higher the costs.

The other point is that we need all the liquid fuels we can get, and there's a place for ethanol and methanol from biomass as well as methanol from coal. That's the key point that is missing in the ERAB report and in the related debate over all synthetic fuels.

Mr. DECKARD. Earlier in our discussions, we talked about the makeup of these various advisory groups and why there is no apparent effort to reach out around the country to find the expertise that's available, rather than continuing to rely on these same old Washington circuit advisers that seem to appear and reappear periodically, and with whom, in many cases, there is at least the suspicion of conflicts of interest.

May I ask the two doctors whether the Department of Energy, for example, has ever been in touch with you for service on any type of official advisory group that might be meeting in Washington, D.C., for the formulation of official Department and administration policy?

Dr. PEART. I have not been. I have been on various U.S. Department of Agriculture committees, but not direct, and some of those have been in dealing with Department of Energy passthrough funds from the Department of Energy to the USDA, but not DOE direct.

Dr. LADISCH. Congressman Deckard, I can't detail all the things I have done, but for the DOE I have reviewed several proposals dealing with energy, which have been sent to my office. I have also at the last, well, not at the last minute, but I was called in on this DOE report, the one entitled "Fuel From Farms," to serve as a reviewer, which I remember quite well. I did that, and I have served on USDA review committees as well.

Mr. DECKARD. So essentially you have reviewed documents for the DOE without taking part in the formulation of the various proposals contained in them.

Dr. LADISCH. No, I have not, but there might be a reason for that in that I have only been in the alcohol field for about 4 years, whereas some of these other people on the committees have been in there 10 or 15 years or so.

Mr. DECKARD. While I was looking through your testimony, it appeared imposing enough for me.

Dr. LADISCH. Thanks for the comment.

Mr. DECKARD. Strictly compared to the results of the study which we have been discussing here today.

Thank you, Mr. Chairman.

Mr. FITHIAN. One technical question. In the absorption process that you have announced this morning, you said you could use ground corn or ground cornstalks or whatever. My question is, first of all, I want to know whether I heard you correctly and that is that you could use it as material to force the diluted alcohol through for the adsorption process—you could use the raw material that's at hand at the site, whether it was a grain conversion process or a cellulosic conversion process. Is that correct?

Dr. LADISCH. Exactly. This is based on laboratory results, and we are now basically scaling it up in our research scale facility; but assuming it works out, and I am pretty sure it will, basically what happens is, you have, for instance, cornmeal or ground up corn stover and a few things like wood chips and you heat these up to about 80° Centigrade. Then you take vapors from your first stripping column, which is not

a very energy-intensive step. You simply pass these vapors through the hot cornmeal or the hot corn stover, and the water is retained in this material. What exits at the top of this column is anhydrous alcohol.

So that avoids altogether, first of all, building several other distillation columns and saves a lot of energy, and it does——

Mr. FITHIAN. Did you have a figure? Did you quote a figure in your testimony of the amount that you expected to save?

Dr. LADISCH. Yes, based on our laboratory results—and this is assuming high efficiencies—we feel we can probably make 1 gallon of anhydrous alcohol, that is, for the distillation or recovery part, for about 12,000 Btu's, starting from a 12-percent solution or 12-percent fermentation ethanol.

Previous figures that have been cited have been as high as 50,000 Btu's per gallon; and there are, though, now commercial stills which claim energy balances between 16,000 and 20,000 Btu's per gallon.

Mr. FITHIAN. Let me ask another question, perhaps of you and Dr. Peart or both, if you would like to comment on it.

There is a great deal of concern in the industrial community and in the academic community, I guess, as well, and certainly in the policymaking end of it as to whether or not, if you get this great investment in one kind of alcohol production, grain alcohol production, whether or not there's any convertibility, should we 4 years hence or 5 years hence, and probably long before we pay for the plant, find that in a given year corn prices are high enough that it's not economically feasible, and that you would gear up or switch over to some kind of cornstalk, city garbage, whatever? I would like to ask what the existing technology response to that would be. Is it possible? Is there interchangeability between the two? What kind of a problem do you get into?

Dr. LADISCH. Just to bring it in perspective, there are basically three steps: one is making sugar; two is fermentation; and three is distillation. Based on what we know now, the fermentation and the distillation steps are exactly the same for both biomass and corn.

Mr. FITHIAN. So the first two steps, no matter which way you are going, whatever the feedstock is, are the same.

Dr. LADISCH. Right; but this assumes that this technology continues to bear out, the one that we are talking about using yeast to make hemicellulose into alcohol.

OK; the first step now appears to be—and I am quite excited about that first thing—within striking distance of being interconvertible, because we have now found a way of hydrolyzing the cellulose portion or the tough stuff into sugars at atmospheric conditions and about 212° Fahrenheit, which is very similar to the conditions used to convert starch to sugars which are subsequently fermented. On this basis, then, I feel with further research we may see down the road that the plant could be retrofitted, so to speak, with some minor adjustments, to be used for either grain or residue materials.

Mr. FITHIAN. But it wouldn't be building a new plant.

Dr. LADISCH. No, I don't think so.

Mr. FITHIAN. You see, the reason I ask the question, Dr. Ladisch, is that as I understood the ERAB report there was a clearly indicated suggestion that any further initiatives to develop the grain-based

ethanol be deferred because a more economic approach might be cellulose 5 years from now or 6 years from now or 7 years from now. That's a policy question that weighs very heavily, not only in Washington, but it weighs heavily at companies out there deciding whether or not they are going to get into this.

Dr. LADISCH. Well, this cellulose hydrolysis, although I can't detail the history of the technical development right now, caught me by surprise; and I should say that 6 months ago I would've had doubts whether this would be done. It has only been recently now that we are getting enough proof on this particular chemistry that at least I am personally satisfied that, given enough time and effort, we may be able to carry it through.

Mr. FITHIAN. Dr. Peart, in your prepared statement you mentioned that you disagreed with the energy-efficiency studies on ethanol used by Dr. Pimentel on technical grounds. For a nontechnical person, could you tell us what the disagreement is? I guess tell me why you think your figures are better than his.

Dr. PEART. Yes. Well, a few of them that are listed here, they use the energy input into manufacturing the farm machinery and then assume that that set of farm machinery would only be used for 62 acres of corn. That seemed very low for us. I would think that that set of machinery would be used in Indiana here, at least, for 400 or 600 acres of corn.

Mr. FITHIAN. So it might be wrong by a magnitude of 10, do you think?

Dr. PEART. Yes. We felt that number was high. The electrical energy was overestimated, we felt, and they did detail in the article how these figures were arrived at. The electrical energy, for instance, was taking the total energy used in agriculture and then allocated all of that to the grain production just according to the proportion of acres; and I am convinced that a lot of that electrical energy actually goes into dairy production and other kinds of production besides grain crops. From our research here on grain drying and corn production, we are convinced that they have the electrical energy overestimated by a lot, also.

Then there was another factor. The yields that they used, they happened to do that work based on the 1970 yields; and, if you will remember, that's when we had the corn leaf blight in the Midwest and that seriously affected the yield. So, the output was less, far less than average. And so that made the energy inputs higher on a per unit output basis.

Those are some of the reasons.

It was a good article from the standpoint that it was the first article where people began to look at the energy inputs into crop production, and so it did a service. It was, I believe, done relatively hurriedly and, using 1970 yields, and it was done some time ago. It was published in 1973.

Mr. FITHIAN. Well, we certainly want to thank you. If you take your figures, if we were to do that and crank them through in the context of the ERAB report, would the ERAB conclusion of gasohol as not energy efficient still follow if you injected or used your figures in terms of energy efficiency?

Dr. PEART. No. Their table would show, even on a Btu, for a Btu basis, that it would be energy efficient in the ethanol figures, because I believe their figure for corn production was 45,000 Btu's per gallon, and we are showing about 23,000 Btu's per gallon. That would more than make up the difference.

Mr. FITHIAN. Finally, I was struck by what I must say was a rather anti-intellectual thrust of one part of the DOE ERAB report. One of the key findings, if I understood it correctly—and I really didn't want to believe that's what they were saying—was that process research, and it's the kinds of things that you are doing at Lorre, and others, that process research, research on distillation processes themselves and the new technologies, more efficient use of grain feedstock and the like, will have little impact, will have little impact on the potential for alcohol fuels. The two scientists here this morning have put a great many years into this study and are known for their own extensive work in the area.

I would like to get a comment from you on that. Am I unduly disturbed by that kind of conclusion, or do you feel that you are essentially at the end of your research and there's not much down the way?

Dr. PEART. I could easily disagree with that statement that research and development would not have any impact upon it. Certainly if it didn't, we should quit doing it. I don't agree with that.

Dr. LADISCH. Well, I think the context of that statement was that using older technology and using the very conservative assumptions that had been discussed previously, for engineering calculations as long as you state them, are correct; that corn composes, I think, 73 percent of the cost of a gallon of ethanol.

However, with these improvements and so forth, it's much less. I believe John gave me a number last week where gasoline, I think, was 50 percent of the cost of a gallon of gasoline from petroleum.

So basically, I guess you could have a policy expert look at that and say, well, due to the small cost differential, it isn't worth it to do the research. However, since I am in research, I feel very strongly that further process research is very dramatically improving the picture. I think it's a very worthwhile thing to pursue, because it will bring down the cost and increase the energy efficiency and help meet the goals that Congress and the President have set for this country with regard to production of alcohol fuels.

Mr. FITHIAN. We are about to close the hearing, but we would welcome any final statement by any of the panelists here.

Mr. CHILDRESS. From the perspective of the work that we have done at the Commission and what we have seen changing just over the last few months, it is important to remember that in dealing with an infant industry in which the unknowns far exceed the knowns, one should not ring the death-knell prematurely as many are doing. As knowledge increases and as the industry grows, we are going to see a growth in the potential contributions that this fuel source can make. I think we are going to be surprising folks within the next year or so, as far as the advances that are made in the alcohol fuels industry.

Mr. FITHIAN. Well, thank you, and let me thank the Chairman of the National Alcohol Fuels Commission, Senator Bayh, for making you available to the panel this morning.

Dr. Ladisch, do you have anything you would like to say?

Dr. LADISCH. I feel, in closing, that I think it's very important that process research of the type that's done at Purdue University, along with agricultural research, is continued and is increased, because I feel that there's a lot of potential in biomass and things like wood chips, of which a lot are available, for instance, in the State of Indiana. Each material has a slightly different chemistry; so, that means you have to work through the entire process for each different material. I think we have a big job ahead of us; and if research and development work isn't done, we won't be able to keep pace with the growth of this industry.

Mr. FITHIAN. Thank you.

Dr. Peart?

Dr. PEART. Thanks. I would just like to agree with that and add to it that the work along with the chemical engineering work on processing, the work on looking at other raw materials as we have talked about, celluloses and methods of handling them, they are bulky, and methods of reducing the cost of handling some of these other materials in addition to corn, I think, are going to really pay off in the years to come.

Mr. FITHIAN. Congressman Deckard?

Mr. DECKARD. Just one short statement, Mr. Chairman. This committee, the Energy, Environment, and Natural Resources Subcommittee, is entrusted with oversight jurisdiction of the Department of Energy and all the various agencies within the Department of Energy. The one thing I would like to reassure the people who are in this meeting today is that we will do everything that we can in the months to come to see that those people within the Department of Energy who are truly interested in promoting gasohol are not hampered by others within the Department of Energy who would like to inhibit its development in favor of other sources of energy, particularly those sources that are so prevalent today, primarily oil. We need to develop, if we are to become energy independent, alternative sources of energy. There are a number of good people within the bureaucracy who are trying to help in that effort; and, as I indicated, there are others who are trying to hinder it.

We intend to continue our oversight of these various agencies to see that alternative sources of energy, such as alcohol-based fuels, are given a fair shot at competing with all of the others and all the other sources. That's our mission, and we intend to try to carry it out to the best of our ability.

Mr. FITHIAN. Thank you, Mr. Deckard, and for coming to the hearing today.

Dr. Peart, I had just one more comment. The report that you referred to briefly, by one of your colleagues in Illinois, if you could make that available to the committee for a part of the record, I think it would be very important. It is in conjunction with that that I would like to say, in closing this hearing today—Congressman Moffett is still tied up on the phone around the corner, and we must bring it to a close—I would like for the people who perhaps have not viewed a congressional hearing before to be aware of the candor of our Department witnesses this morning. It is absolutely refreshing for those of us who have sat on the receiving end of testimony for many, many

hours, from many, many departments. I would like to think, though, maybe it was because we came out to Indiana and the fresh air sort of cleared their minds. I don't want to be that provincial. I think perhaps it is because there is a new breed coming into being at the Department that are unwilling to accept older interpretations and older data and are enthusiastic enough and open enough to consider new ideas.

I think that Mr. Greenglass and Mr. Holmberg—I can't think of the other two right now, but the four witnesses we have had here from the Department this morning was for me a remarkably refreshing and candid approach. I want to thank you for coming out. We shall thank Secretary Duncan for making you available to us this morning.

I certainly want to thank the experts on the panel for evaluating the fundamental questions, for procedural quarrels are one thing. The facts of life for alcoholic fuels are quite another. I think the panel has established a record here this morning that, once published, will be made available to those who really care at all about alcohol fuel and try to get at the bottom of it.

Particularly for the media and the public present, I want to reassure you and to urge you to focus on the fundamental questions that were asked here and answered here in this last panel. The fuel versus food question still rambles out all across the country. The question that Dr. Peart addressed himself to, "Does it take more fuel, more energy to make a gallon of alcohol than you get from it," although it seems to me now definitive, it still gets asked everywhere you go.

Certainly Dr. Ladisch, who has worked with Dr. Tsao at Purdue on the frontline of the breakthrough that will open up a whole new horizon for energy, for when you go to cellulose you are not talking about any grain limitations, but you are talking about practically the whole universe of plantlife which is cellulose, and the exciting work that is being done there, I think, is clearly among the most interesting and worthwhile and useful in the country.

Let me finally say that in the reference that you made, Dr. Peart, to the balance that we ought to strike in national policy with regard to whether you import more oil or make it at home, we have had economists look at this; and sometimes those of us who are enthusiastic supporters of alcohol look at it one way and others look at it another way.

What I would like to urge to the people concerned about this issue, look at it, if for no other reason, in a national security sense. I can make the economic case for alcohol and I am a 100-percent supporter but I don't see very many people today talking about fuel as a basic ingredient of national security. Yet, you don't really have to be a historian, you don't have to be an international relations expert to realize that the thread by which our whole national security hangs today is a handful of very unstable, potentially unstable countries. In fact, whether or not we would be able to put a military effort in the field might well depend on whether or not, at that particular juncture, the Saudi Arabian princes were getting along with each other. Quite literally, it is in that dimension that I think we must address the issue of getting additional fuel made at home.

The overwhelming arguments that have been made here today in terms of the economics of it and the support for it from our friends here this morning from the Department of Energy is encouraging,

but I think the urgency is sometimes overlooked. The urgency really is that we must not allow this country to remain hostage to the producers of oil in a handful of countries far, far away who do not have our best interests as their interest, as their concern. And so, even if it weren't as good economically, even if the energy balance, Dr. Peart, were not quite what you say it is—and I think it is at least what you say it is—even if there were no new hope for the future, Dr. Ladisch, we really ought to do it anyway. We ought to do it for the national security issue and the additional security safety of the country. If for no other reason, that's enough to justify everything and anything we do.

Finally, let me say that my own animus and my own thrust and my own irritation at Mobil Oil for attempting to block this is in no way geared to a feeling that we ought to throw out the methyl alcohol solution or that whole process or we ought to stop any taxpayers' dollars being used by Mobil to develop a process from which they will profit. I hope they do profit from it. I hope that 5 to 6 years from now methyl alcohol is available in large amounts, and ethyl alcohol is available in large amounts, because we are going to have to have all of the kinds of available resource energy, and certainly the conversion of coal to this, if we're even going to begin to make a serious effort at making up the other half of the oil production for which we are now dependent overseas. So, I am not opposed to the support of Mobil's process. I just wish they were not opposed to what other people are trying to do, for I believe that America was built on competition. I think that's what made this country what it is. One of the reasons that some of us have been engaged in this alcohol fuels movement is that we do not believe there's adequate competition in the liquid fuel energy field today; therefore, if we can bring 10 percent of our liquid fuel from alcohol, ethanol alcohol sources, fine. And if another x percent comes from methanol alcohol sources, fine. Combined, the available resource energy will bring back competition to the liquid energy field which is rapidly disappearing. For a whole lot of reasons, I think it was important and it is important that we not allow what I must conclude was a hastily drafted, ill-conceived and untimely delivered report to become the basis for the national policy of the United States.

I want to thank the staff for their careful preparation and the cooperation of the Department of Energy in going through the documents.

I want to thank Congressman Moffett for coming out here.

I want to thank Congressman Deckard for coming up from down the river.

I want to assure all of you in the Department and who are the experts that certainly this subcommittee will not forget its responsibility as the chief energy environment oversight committee for the House of Representatives.

The hearing is adjourned.

[Whereupon, at 11:55 a.m., the subcommittee adjourned, to reconvene subject to the call of the Chair.]

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APPENDIXES

APPENDIX 1

REPORT OF THE

ENERGY RESEARCH ADVISORY BOARD

ON

GASOHOL

PREPARED BY THE

GASOHOL STUDY GROUP

APRIL 29, 1980

Department of Energy
Washington, D.C. 20585

May 2, 1980

The Honorable Charles W. Duncan, Jr.
Secretary of Energy
Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Mr. Secretary:

I am pleased to transmit the report developed by the Energy Research Advisory Board's Gasohol Study Group. The members of the Study Group were selected for their technical expertise, prominence and integrity. The report has the endorsement of the Energy Research Advisory Board.

The principal conclusions of the Study Group are as follows:

1) Ethanol production as a near-term (mid-1980's) partial solution to the liquid fuels problem (based on current incentives) will probably reach 200-300 million gallons per year by 1985. Thereafter, about 800 million gallons of ethanol could be produced per year. This level of ethanol production would displace an equivalent of 26,000 barrels of oil per day or less than one percent of U.S. gasoline consumption; and

2) utilizing the best available technology before 1985 the net energy balance is about zero for ethanol produced from corn and other crops in fermentation/distillation plants. If the fermentation/distillation plants are fueled by coal or wood, each gallon of ethanol produced could save roughly 0.5 gallons of oil.

These and other conclusions and recommendations in the report are based on the best data available to the Study Group at the time it conducted the study (December 1979). The study itself was undertaken on a quick turn-around basis to address some specific issues then of interest to the Department. The draft report of the Study Group was discussed at the February meeting of the Board. As a result of that discussion the draft was modified to clarify some of the points made in the original draft.

The Board also received comments from members of the public at the February and May meetings of the Board. Most of these comments addressed the benefits of small-scale operations and the long-range prospects for gasohol. The benefits of small-scale operations are recognized in the report but perhaps are not highlighted to the extent some would desire. Both matters deserve further research.

I realize that the gasohol issue is in a continuous state of flux. The Board is prepared to render additional assistance should you require it. In any case, as new data becomes available the Board's Biomass Panel will study the matter as part of its overall charge.

Sincerely,

Solomon J. Buchsbaum, Chairman
Energy Research Advisory Board

Attachment:
As Above

68-281 O - 80 - 7

NEW YORK STATE COLLEGE OF AGRICULTURE AND LIFE SCIENCES
A STATUTORY COLLEGE OF THE STATE UNIVERSITY
CORNELL UNIVERSITY
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DEPARTMENT OF ENTOMOLOGY
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Reply Address:
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29 April 1980

Dr. S.J. Buchsbaum
Executive Vice President,
Customer Systems
Bell Laboratories
Crawford Corner Road
Holmdel, N.J. 07733

Dear Dr. Buchsbaum:

I am pleased to submit the Gasohol Report prepared for the Energy Research Advisory Board by the Gasohol Study Group. In our search for alternative sources of liquid fuels for the future, the potential of gasohol should be carefully evaluated. The use of food grains for alcohol production raises several important issues. In its deliberations the study group considered these issues from a broad perspective including the energetics, economics, social, agricultural, and environmental aspects.

Clearly there are benefits as well as risks in the production and use of alcohol for gasohol. We must emphasize that a major effort to convert food grains into alcohol using no-oil/gas-fired distilleries will supply the nation with about 800 million gallons after 1985. This amount of alcohol used as gasohol would replace the equivalent of 26,000 bbls of oil per day or less than 1% of current gasoline consumption.

We hope that this report will be of value to the Energy Research Advisory Board.

Sincerely yours,

David Pimentel
Chairman, Gasohol
Study Group

DP:sp

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OF THE
ENERGY RESEARCH ADVISORY BOARD

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Introduction

The United States must find alternative sources of liquid fuels for the future. One alternative that has received a great deal of attention is gasohol (a 10% ethanol and 90% gasoline mixture). The Gasohol Study Group was asked to investigate the following questions:

(1) What are the potential benefits of gasohol from both an energetic and economic perspective?

(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 additional tax incentives needed for gasohol production?

Findings

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/distillery plants were fueled by coal, then each gallon of ethanol produced could save roughly 0.5 gallon of oil.

(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% of U.S. gasoline consumption.

(3) 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.

(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.

(5) The cost of corn constitutes about 73% of the manufacturing cost of ethanol; hence, process research directed to other areas of cost reduction will have little impact.

(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.

(7) Current tax incentives for ethanol production, especially state tax rebates, appear to be more than adequate to encourage investment today with existing technology.

(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.

(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.

(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.

(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 commercialize until after 1985.

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 1980s. 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.

(2) Gasohol production, stimulated by high subsidies, will reduce the amount of grain available for meat, milk, and egg production.

(3) Gasohol production will intensify environmental degradation with standard crop culture technology because of greater pressure for the use of land for agricultural production.

(4) Ethanol can be produced on individual farms in small-scale operations and the wet stillage fed to livestock. Assuming that woody residues were available on the farm as a distillation fuel, then there would be net energy benefit for these small operations. Although the total energy contribution will probably be small, these small-scale units would offer a degree of family self-sufficiency.

(5) The supply of grain available for gasohol and livestock production will continue to vary from year to year due to climatic variability and world food demand. This variability in grain supply will have an important impact on gasohol production.

(6) The pool of grain[1/] available for gasohol and livestock production is projected to decline in the future because of the rapidly growing world population and demand of this grain for food. Even without gasohol production, projections are that both demand and prices for grain on the world market will increase.

Forestry and Agricultural Residues for Gasohol Production

(1) Forestry residues and waste products are a major resource with potential to produce about 27 billion gallons per year of ethanol with production beginning in 1985-1990 by fermentation routes (this technology, however, requires additional research). Utilization

1/ This takes into account the distillers' grains available for livestock.

of these materials should not compete 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 in the late 1980s for commercialization.

(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.

Methanol Production from Coal

(1) The capital cost for one 500 million gallon/year methanol production plant is approximately the same as for twelve 50 million gallon/year ethanol fermentation plants.

(2) Methanol as well as ethanol contribute some problems in automobile engine operation with methanol causing more problems.

(3) The conversion of coal directly to methanol is projected to cost about one-half to one-third that of ethanol production from grain.

(4) Methanol production technology[1/] from coal or natural gas is commercially available now and is capable of producing methanol on a large scale. Future cost reductions may be achievable first by initiation of commercial coal-processing plants to allow

[1/] Natural gas conversion technology is available in the United States whereas coal conversion technology is available outside the United States.

"learning curve" improvements, and then by research and development in the coal gasification step, which carries the major burden of the capital investment.

(5) Given adequate guarantees for product revenue, commercial production of methanol from coal is achievable by the late 1980s.

(6) 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.

Recommendations

(1) Current incentives for investment in ethanol production for gasohol are adequate and should not be increased. For facilities where there are significant oil savings from the production of ethanol, assurances should be required that they will not be fueled by oil or gas. Tax incentives should be tied to this condition.

(2) Ethanol production as a near term, mid-1980s limited contribution to the liquid fuels problem should be allowed to find its own level based on current incentives, with a high probability of reaching 200-300 million gallons per year by 1985 (assuming no oil and gas is used in distillery). Production of 800 million gallons of ethanol per year, if obtainable thereafter, could provide sufficient ethanol to blend about 20% of current U.S. unleaded gasoline as gasohol. This gross ethanol production would displace an equivalent of 26,000 bbls of oil per day or less than 1% of U.S. gasoline consumption.

(3) Tax incentives should be monitored carefully to insure that alcohol production from grains and other food supplies does not reduce the availability of feed supplies for meat, milk, and egg production and lead to further inflation in foods. In fact, current subsidies may already be excessive for modern low-cost ethanol plants.

(4) An additional incentive in the form of protection of investment (whether equity or loan-financed) over the investment lifetime would insure capital investment in new alcohol plants.

(5) Additional financial initiatives to promote more dramatic increases in ethanol production above those mentioned should not be implemented because of the likely advent of lower cost alternative liquid fuels, such as methanol from coal and ethanol from cellulose in the 1990s.

(6) National land use policies are needed to prevent environmental

degradation associated with an expanded effort to produce grains and other crops for gasohol production.

(7) Assessments of fuel replacement equivalents of ethanol compared with gasoline beyond their BTU equivalents are currently inconclusive and await completion of sound automotive fleet tests.

(8) Progress toward implementation of other lower cost technologies (methanol from coal, other synfuels, etc.) must be monitored carefully with the expectation that their relative merits and timetables will be more clearly discernable by the mid-1980s. If practical lower cost alternatives to ethanol are not emerging, a more massive ethanol effort may be called for, using cellulosic biomass as a substrate.

(9) Markets should be monitored to insure that ethanol from ethylene from petroleum is not used to replace fermentation ethanol used for gasohol. Producing ethanol from ethylene derived from oil does not contribute to the nation's energy needs.

(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. Research is especially needed on problems of land and water resources and oil and gas inputs that are required to support sustainable agricultural and forestry biomass production systems.

(11) Alcohol production from coal should be encouraged because this technology has the future potential for lower costs than alcohol production from grain; has vastly greater liquid fuel availability for the nation; and would have less impact on food production and prices than the alcohol/grain technology. (The panel considered only transportation and did not give consideration to all other potential uses).

(12) The alternative of direct production of alcohol from coal should be encouraged by some government assistance.

(13) Any U.S. program for gasohol production should take into consideration the world food problem and the future demand by developing nations for grains and other foods.

(14) The environmental issues arising from methanol production from coal should be examined in more depth, and the benefit of the lower cost of methanol should be balanced against the perceived risks. This balance should be weighed in turn against the same analysis for a comparable level of ethanol production to help determine priorities for the two principal alcohol technologies.

An Assessment of Gasohol Potential

Energy Balance

The energy balance for existing fermentation ethanol technology with existing petroleum or gas-fueled plants is about zero; i.e., there is no net consumption or gain in energy (Table 1). Most U.S. fermentation/distillation facilities today are in fact oil or gas-fueled. Savings calculated from decreased energy for gasoline production at the refinery slightly increase the net savings. Energy efficiency in the fermentation/distillation plants can be improved through advanced technology, but the impact on net energy will be small (Table 1). The largest effect will be obtained from fermentation/distillation plants that derive their energy from sources other than oil or gas, primarly coal. (The use of crop residues will be limited [see pages 19 and 20]). Effectively, then, with oil-and gas-derived energy consumption in fermentation/distillation plants reduced to zero, the net savings is about 53,000 BTU (LHV) per gal of ethanol; this is the equivalent of about 0.5 gallon of gasoline (@ 115,000 BTU [LHV] per gal) (Table 1).

Using no high fuel (oil and gas) in the fermentation/distillation plants and assuming that about 9 million tons of grains were available, production of ethanol could reach 800 million gallon/yr. If blended with gasoline, 20% of the current national unleaded gasoline requirement could be available as gasohol. This would displace an equivalent of 26,000 bbl oil per day or less than 1% of U.S. gasoline consumption.

Cost of Gross Alcohol Fuel Produced at the Distillery

The corn raw material dominates the production costs (73% of the overall cost) in a 50 million gallon/year fermentation plant (Figure 1). Only about 15% of manufacturing costs are susceptible to process improvements such as continuous fermentation and membrane separation techniques (Hartline, 1979).

In contrast to manufacturing costs, a specific projection of selling price is not presented because selling price is subject to considerable variation depending on the extent of debt financing and the assumptions in the DCF[1/] calculations (e.g. 15% vs. 20%). Projections of profitable ethanol selling prices from new plants range as low as $1.20 per gallon at the plant gate (OTA, 1979). These figures are more sensitive to financial consideration than to likely technological advances. Definitive price projections must be determined on a case-by-case basis.

Process costs are also sensitive to plant size. At a plant with a 10 million gallon/year capacity, ethanol production costs would be increased by about one-third (DOE, 1979a; Honohan, E.J., 1979, Personal communication, Pfizer Inc.). Small plants may be profitable in selected situations with favorable raw material supplies (e.g., food processing wastes) that help offset increased operating costs. Farm distilleries also may be helpful in alleviating local effluent waste problems. Such farm operations are not likely to have a significant impact on gasoline supply, but may provide some benefits to a few people who desire a sense of self-sufficiency in their operations.

Cost of Net Fuel Produced

If no high grade fuel energy (oil or gas) is used in the distillery[2/], 1 BTU of fuel energy produces about 2 BTUs of alcohol fuel energy; the agricultural process consumes the 1 BTU of energy. Although the equivalent yield of 2 gallons for 1 is positive, the process of producing the net ethanol fuel energy is expensive.

First, the 2 gallons are produced at a price of $1.20 per gallon or a total of $2.40. If the $0.26 [3/] cost for fuel input is

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1/ Discounted Cash Flow.

2/ Coal fired fermentation/distillation plants.

3/ Gasoline costs $0.48 and natural gas $0.30 per 115,000 BTU--the 76,000 B of high grade fuel is assumed to be half gasoline and half gas (Anonymou 1977a; AGA, 1979).

subtracted from $2.40, then the real cost to produce 1 net gallon of new fuel energy as alcohol is $2.14. If future automotive fleet tests demonstrate that the gasohol blend is mechanically equal to gasoline, then the real cost will be slightly less than $2.14.

Current federal and state tax incentives run as high as a $1.13 per gallon (DOE, 1979b). These tax incentives make alcohol competitive with gasoline, but it must be recognized that consumers pay the total bill per gallon of alcohol produced and used.

The cost of producing methanol directly from coal in terms of gasoline replaced (see pages 22 and 23) has been estimated[1/] to be between $0.40 and $1.00/gal. If "octane number" credits were applied as they are sometimes proposed for grain ethanol, they would have also to be applied to synthetic methanol and reduce their effective costs.

Ethanol from Ethylene

There is some evidence that ethanol from ethylene is being used to replace fermentation ethanol (CMR, 1979). It is undesirable when ethanol from oil-derived ethylene is used in gasohol because oil is being converted into another form of liquid fuel and, therefore, is not providing a net gain in liquid fuels for the nation. Thus, markets should be monitored to insure that ethanol produced from ethylene is not being used to replace fermentation ethanol used for gasohol production.

1/ Based on methanol costs of $0.20 to $0.50 per methanol gallon, multiplied by 2 to obtain BTU equivalence.

Impact of Gasohol Production on Food and the Environment

Competition for the Grain Resource

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 (Pimentel et al., 1980a). The effect can be illustrated by reexamining the situation that occurred in 1973-74 when world demand for grains increased and U.S. exports of grain increased--prices of U.S. grains more than doubled (corn rose from $1.15 to $3.05/bu [USDA, 1975-76]). Because it was unprofitable to raise livestock with high-priced grain, farmers sent large numbers of animals to market and the amount of grain fed livestock declined by nearly 30% (Figure 2). As a result consumers paid high prices for meat, milk, and eggs (USDA, 1972-77).

Basically because livestock and gasohol production use the same resource, they will compete for surplus grain. Therefore, incentives to encourage gasohol production must be set and carefully monitored so that the availability of grain for livestock production is not seriously reduced; otherwise animal protein prices will rise and result in added inflation.

Furthermore, even with the current incentives to encourage the use of grain for gasohol, its production is as sensitive to grain price changes as is livestock production (Pimentel et al., 1980a). If, for example, grain prices were to rise three-fold or more a bushel, as occurred recently, gasohol as well as livestock systems would be affected.

The projected trends for the world grain market are increasing grain demands (NAS, 1977). The prime reasons for this are: (1) a rapidly growing world population--at least a 70% increase in the next 25 years--will require more food (NAS, 1977); (2) most cropland in the world is already in production (NAS, 1977); and (3) grain yields per acre in the world are declining due to land degradation and other factors (Brown, 1979). Therefore,

assuming increased world demand for grain, U.S. grain prices will increase. This, in turn, will reduce the amount of surplus grain that is available for livestock and gasohol production. Whether the grain is utilized in the world community depends upon numerous factors including: (1) seriousness of famines; (2) grain prices; (3) ability to pay or economics; (4) balance of payment problems; and (5) politics.

Land Use and Degradation

Land available for grain production in the United States is limited[1/]. The total set aside land acreage in 1972 was about 60 million acres. Because of the high grain prices for export in 1974, this acreage abruptly dropped to zero. Although the set aside land is now 15 million acres, it can be expected to decrease as the demand for grain on the world market and grain prices rise. In addition, it should be pointed out that about 2.5 million acres of cropland is lost annually to highways and urbanization (USDA, 1971). Although the rate of loss may decline with reduced automobile use, the U.S. population growth, projected to increase 24% during the next 25 years, will probably keep the loss at high levels (USBC, 1976).

Some cropland, about 40 million acres, that is currently in pastures could be converted into grain production (USDA, 1979). However, this is marginal cropland and therefore for the same agricultural energy input, the yields would be less than average. In addition, the forage that is being produced on the land would no longer be available to livestock and other suitable feed would have to be found.

1/ Various agricultural systems have been proposed that include interplanting and integrating multiple crop systems with livestock production systems suggesting that crop and livestock technology could be improved (Pimentel et al., 1973; Pimentel and Pimentel, 1980; Carlson et al., 1979a; 1979b; Commoner, 1979). Whether these proposed systems will function effectively and economically remains to be tested.

Raising grain and sugar crops with current agricultural technology degrades the soil[1/]. Over a 25-year period, with corn production, for example, it is estimated that an additional 12 gal of fuel equivalents per acre per year would be needed in the form of fertilizers and other fossil energy inputs to offset this degradation (Pimentel et al., 1980b). Therefore, land degradation must be included in any energy input/output analysis for gasohol production.

Variable Grain Supplies

A major dilemma in the long term in using grain as a resource for ethanol production is how much surplus grain will be available in the future (Pimentel et al., 1980a) This depends on climatic trends and world food production (USDA, 1967-79). Climate has become more variable and this has influenced the annual grain yields in all regions of the world (including the United States) and in turn has significantly influenced world grain demand and prices (Brown, 1979; Pimentel, 1979). Poor climatic conditions in the future could have dramatic effects on the world food problem (Schneider 1978).

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 as a result could have major impact as a raw material for production of alcohol (DOE, 1979b). Cellulosic biomass contains approximately equal parts of cellulose, 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.

1/ Numerous agricultural technologies exist for controlling soil erosion and degradation and these technologies have been available for more than 40 y (Bennett, 1939). Although the technology has been available for several decades and over $15 billion spent since 1935, soil erosion has not decli and remains a serious problem today (GAO, 1977; SCS, 1977).

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 (Larson et al., 1978; Pimentel et al., 1980b). For these reasons, agronomists and other agriculturalists recommend that corn residues, for example, be harvested only on land with a 0-2% slope (Gupta et al., 1979). Furthermore, for each acre, at least 1500 lb of the 5000 lb of corn residues should be left on the land and conservation tillage employed (Larson et al., 1978; Gupta et al., 1979).

It is estimated that about 3500 lb of corn residue per acre could be removed from about 20% of the land currently used for corn; i.e., land with a slope of 0-2% (Gupta et al., 1979). In addition, 1200 lb of small grains residue per acre could be removed from 25% of the land used for small grains, primarily wheat (Pimentel et al., 1980b), these estimates assume that good conservation practices would be employed and nutrients removed would be added back as commercial fertilizer. 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% slope) currently used for corn production (Pimentel et al., 1980b). The estimated potential alcohol production from crop residues is about 1.9 billion gal per year (Table 2).

The cost and energy input for collecting and transporting crop residues are significant. For example, in Illinois the price per delivered dry ton of crop residue is $36 to $53 within a 15 mile range (USC, 1978). This is from $2.40 to $3.50 per million Btu's and thus is more expensive than coal.

The energy input for collection and transport of corn residue is estimated at 200,000 BTU per acre (Pimentel et al., 1980b). 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 gals of alcohol per acre) of utilizing corn residues.

Forest residues and products provide a major biomass resource (Pimentel et al., 1978). The anticipated availability of noncommercial and therefore noncompetitive wood from forest biomass, and its potential annual yield of pure ethanol is about 20.5 billion gallons per year (Table 2). 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 (DOE, 1979b). This technology is practiced by only one commercial firm as a pilot plant operation (DOE, 1979b).

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 (SERI, 1979). 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.

With presently emerging technology, we can expect to see implementation of cellulose 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. In contrast to the use of grain and sugar crops, the conversion of cellulosic biomass to alcohol should offer no competition with respect to grains and other foods. Furthermore, there should be no significant impact on the sustained favorable trade balance deriving from grain exports (USDA, 1979).

The use of conservative agronomic practices for use of crop residues should be obligatory to avoid soil degradation (Larson et al., 1979; Gupta et al., 1979; Pimentel et al., 1976; Pimentel et al., 1980b). In any case, there should be close monitoring of soils used in this fashion to assure that degradation is not occurring because the nation already has a serious soil erosion problem (GAO, 1977; SCS, 1977). In the case of forest biomass destined for conversion to alcohol, its harvest will have less environmental impact from soil erosion and water runoff compared with crop residues, as long as conservation practices in culturing and harvesting are used. The environmental problem with forests, however, has not been investigated well and requires a great deal of research before any major program is considered in using forest residues and products for ethanol production (Pimentel et al., 1979; Pimentel et al., 1980b).

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.

Methanol Production from Coal

Methanol production from coal can be practiced on a large commercial scale using known technologies of coal gasification and methanol[1/] synthesis (Morel and Yim, 1977; DOE, 1978; Schreiner, 1978; Bailey, 1979; Kasem, 1979). Such processes could be in production as early as 1985 with suitable incentives.

Several variants have been evaluated by DOE (DOE, 1978; Schreiner, 1978). One example would be conversion of lignite, using the Koppers-Totzek gasification system coupled with the ICI[2/] methanol production process (Anonymous, 1977b). Process efficiency is considered to be about 50%.

For a typical case, the proposed plant has a capacity of 6,600 tons-per day methanol or about 48,000 bbls/day (SRI, 1978). Coal consumption is 19,000 tons per day of which 4,700 are consumed for plant use and 14,300 are processed to methanol. Sited near a coal mine, total capital investment would be about $1 billion with 100% equity financing. With coal costing $8.40 per ton, the selling price of methanol would be $0.67 per gallon for 15% DCF (Table 3).

1/ Methanol can be converted directly to gasoline employing the MTG process (Meisel et al., 1976; Lee et al., 1980).

2/ Imperial Chemical Industries.

A second example presented in Table 3 is the use of Illinois #6 coal to produce 7,300 tons of methanol per day or about 55,000 bbls, by a Texaco partial oxidation gasification system coupled to a Chem System methanol conversion synthesis process (SRI, 1978). With coal costing $29.40 per ton, the cost of methanol is $0.53 per gallon at 100% equity.

Other more detailed estimates for manufacturing costs of methanol have been made by contractors of DOE (SRI, 1979). The methanol costs are estimated to lie in the range of about $0.20/gal for an optimistic case (involving majority debt financing) to $0.50/gal for a more realistic case (involving 100% equity financing). This range corresponds to $0.40 to $1.00 per gasoline equivalent gallon.

The use of methanol and ethanol as blends with gasoline causes problems in automotive engine operation (DOE, 1979a); methanol results in more engine problems than ethanol.

Potential environmental problems associated with coal conversion to methanol are a major concern (NAS, 1979). These environmental impacts include: agricultural and forest land damage; air and water pollution; water use in water-short regions; and degradation in natural biota. The trade-offs between lower methanol production costs from coal and the potential environmental impacts must be carefully weighed.

Table 1. Energy Balance for Ethanol Production from Corn.[a]

	Thousand BTU/gallon[b]	
Consumed	Best Available Technology High Quality Plant Fuel	Future Coal-Fueled Plant
Fermentation/ distillation[c]	69	0[d]
Farming[e]	45	45
Total	-114	-45
Produced		
Ethanol	76(130)[f]	76 (130)[f]
By-product Animal Feed[g]	11	11
N value of crop residue[h]	3	3
	+90 (+144)[f]	+90 (+144)[f]
Net	-24 (+30)[f]	+45 (+99)[f]
Refinery Credit	+8	+8
	-16 (+30)[f]	+53 (+99)[f]

a/ 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 (E.J. Monahan, 1979, personal communication, Pfizer Inc.).

b/ For consistency, all heating values are expressed as LHV (low heating values)

c/ 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; Hertzmark, 1979; Weisz and Marshall, 1979; Chambers et al., 1979). For a modern 50 million gallon per year ethanol plant about a 69,000 BTU input is calculated per gallon of ethanol produced using vapor recompression evaporators (about 100 BTU/lb of water evaporated)(E.J. Monahan 1979, Personal communication, Pfizer Inc.).

Table 2. Estimated Available Cellulosic Biomass and its Potential for Ethanol Production for after 1985.

Crop Residue	Amount Available (million dry ton)	Ethanol Production[a] (billion gal alcohol)
Corn[b]	15	1.2
Wheat[c]	9	0.7
Forest Biomass		
Wood as Residues[d]	120	9.3
Fuel wood production[e]	120	9.3

a/ The yields in alcohol listed below are estimated yields by Charles Cooney and Jack Spurlock. The energy costs for collection, transportation, and fertilizer replacement of the nutrients removed with the biomass are not included in the ethanol production.

b/ Corn residue values were taken from Table 3A of "The Report of the Alcohol Fuels Policy Review: Raw Materials Availability Report" DOE/ET-0114/1, Sept. 1979. It was assumed that 70% of the residue could be removed from 20% of the land currently used for corn.

c/ Wheat residue, the largest of small grains residue, values were taken from the same Table as in b/. It was assumed that 45% of the residue could be removed from 25% of the land used for wheat.

d/ Franklin, 1973; J. Zerbe, 1978, USDA-Forest Service.

e/ It is assumed that the 60 million acres of forest land could be converted into fuel wood farms without seriously affecting forestry production (Pimentel et al., 1978). The yield was assumed to be 2 tons per acre per year.

Table 1, footnotes, continued.

d/ Assumed to be zero because coal is substituted for oil and gas.

e/ 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, 1978; DOE, 1979b; Hertzmark, 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).

f/ 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 115,000 BTUs or as an equivalent of crude oil is 130,000 BTUs. A serious question exists concerning the assumption that a mechanical equivalency of gasohol as gasoline exists.

g/ 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; Hertzmark, 1979; Weisz and Marshall, 1979; Chambers et al., 1979). For a 50 million gallon per year ethanol plant with a well-designed drying facility, a credit of about 11,000 BTU was calculated

h/ Crop residue contains about 1% nitrogen, 0.1% phosphorus, 0.9% potassium, 0.6% calcium (NAS, 1978). Energy value as fertilizer was calculated to be 3,000 BTU.

Lignite Conversion to Methanol at $8.40/ton

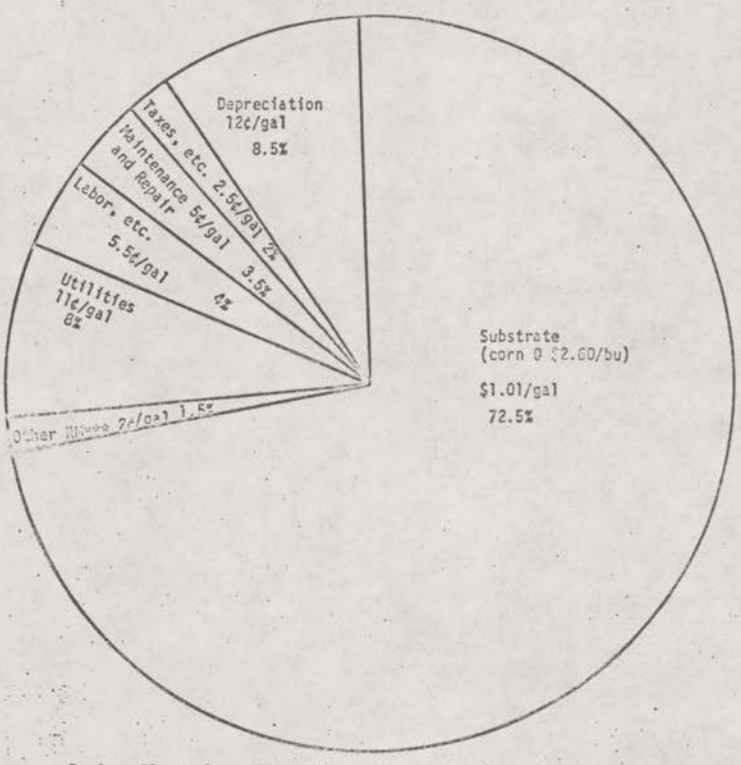
	$/gallon 1980	
Materials	0.09	
Labor	0.06	
Utilities	0.01	
Other Operating Costs	0.14	
	0.30	
Return on Investment at 15% (DCF*)	0.67	= $10.4C/million BTU

Bituminous to Methanol at $29.40/ton

	$/gallon 1980	
Materials	0.14	
Labor	0.04	
Utilities	0.01	
Other Operating Costs	0.09	
	0.28	
Return on Investment at 15% (DCF*)	0.53	= $8.27/million BTU

*Discounted Cash Flow

Figure 1. Manufacturing Costs* of Corn to Ethanol Based on Best Available**** Technology (E.J. Monahan, Dec. 1979, Personal communication, Pfizer Inc.). Ethanol price is $1.39/gal (before by-product animal feed credit)**.



Basis - Plant size: 50 million gallons ethanol/yr
Fuel: Coal @ $25/ton

Fixed Capital Investment - $75 million
*Manufacturing cost only - profit not included
By-Product credit could be as high as $30/T (P.A. Oltenacu, Personal communication
Animal Science, Cornell U., Dec., 1979
**Best Available Technology defined as the potentially most effective and accessible technology through 1985.

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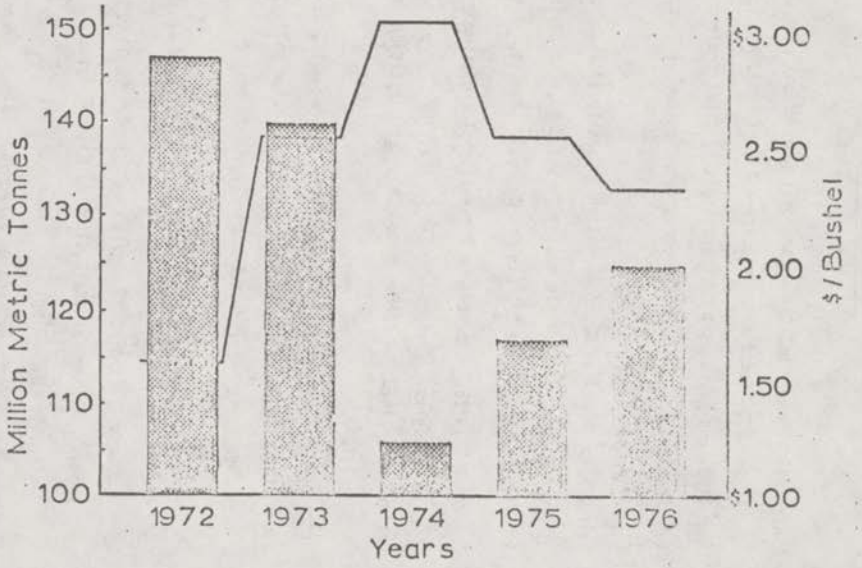
Figure 2. Amounts of cereal grains fed livestock from 1972 to 1976 (USDA, 1977). Average price of corn as an index of grain price changes (——).



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APPENDIX 2

DRAFT

July 26, 1980

Department of Energy
Washington, D.C. 20585

MEMORANDUM FOR THE SECRETARY

FROM: Bert Greenglass, Acting Director
Office of Alcohol Fuels

SUBJECT: OAF Response to Report of the Energy Research Advisory Board on Gasohol

Attached is the Office of Alcohol Fuels' response to the Energy Research Advisory Board (ERAB) Gasohol Report of April 29, 1980. As directed, this Office has conducted a review of the ERAB Gasohol Report and has responded in detail to the ERAB Report's recommendations. This response was prepared with information and assistance from the Solar Energy Research Institute (SERI), the National Alcohol Fuels Commission, the National Gasohol Commission, the National Alcohol Fuel Producers Association, EG&G Idaho, Inc., Congressional staff, and several other groups and individuals.

The principle conclusions of the Office of Alcohol Fuels are as follows:

1. The National Alcohol Fuels Program can and will meet the Administration's ethanol production goals, as well as those set by Congress in the Energy Security Act of 1980 (P.L. 96-294). The ERAB Gasohol Study Group estimates for 1985 ethanol production, which fail to take into account significant Administration and Congressional initiatives, are so conservative that one Illinois company alone expects to produce the ERAB Study Group's 1985 production estimate by the end of 1981.

2. Production of ethanol from biomass is commercially available and in widespread operation throughout the country today. The growing alcohol fuel industry is already reducing our dependence on imported oil through increasing domestic ethanol production. On the other

hand, while methanol production from coal looks attractive to the ERAB Gasohol Study Group and oil companies such as Mobil Oil, which is involved in the methanol to gasoline process, it is an unproven technology only now approaching the evaluation and demonstration stage in the U.S. Until acceptable plant reliability and extended operating experience are achieved with methanol from coal, production cost estimates are not credible. While methanol as an alcohol has promise as a high grade liquid fuel, the Gasohol Report used assumptions and outdated information to needlessly pit one alcohol fuel against the other. Both ethanol and methanol are needed to back the nation out of the foreign oil barrel.

3. Many technological and energy-saving advances in ethanol production processes are occurring at an accelerating pace. The Office of Alcohol Fuels is working with ethanol producers in many parts of the country who are realizing substantial energy gains now and expect even greater efficiencies in the near term. With these advances, the net energy balance of alcohol fuel production will continue to improve. The Office of Alcohol Fuels calculates that each gallon of domestic ethanol produced will permit a reduction of at least 1.5 gallons of imported crude oil -- three times the ERAB figure.

4. The Administration's ethanol production goals can be met without an adverse effect on food supplies or prices. There are significant opportunities to use agricultural and food processing waste products and to develop high-yield energy crops for substantial production of ethanol, thereby reducing cost to the consumer. Further, the ethanol from grain process produces valuable, protein-rich co-products which are suitable for export and domestic use.

5. Farm-scale ethanol production can strengthen the family farm by generating a steady cash flow to farmers while providing an uninterruptible supply of high-grade liquid fuel to power farm machinery leading to the eventual liquid fuel independence so much desired by the farming community. As a result of the Administration's ethanol program, interruption in imported oil deliveries will not seriously interrupt domestic food supplies to consumers. Farms producing ethanol can lessen the impact of rising energy prices on the cost of their products, thus keeping food prices to the consumer at an acceptable level.

In issuing its Gasohol Report, the ERAB Gasohol Study Group failed to take into account several events which occurred during the intervening period between the first draft and final report. The following events, which have substantial impact on alcohol fuels development, occurred during this time:

1. On January 11, 1980, the President announced a comprehensive National Alcohol Fuels Program to accelerate domestic production of alcohol fuels from biomass. The Program seeks to quadruple January 1980 alcohol production capacity by the end of 1980, and sets a target for domestic production capability of 500 million gallons during 1981.

2. On February 14, 1980, the Office of Alcohol Fuels was created within the Department to promote ethanol production from biomass, and to implement the Administration's Alcohol Fuels Program.

3. On April 2, 1980, the Crude Oil Windfall Profit Tax Act of 1980 (P.L. 96-223) was signed into law by the President. Among other incentives, the act continued for eight more years, from 1984 through 1992, the four cent per gallon federal excise tax exemption for gasohol; provided new income tax credits for alcohol-gasoline blenders; and extended through 1985 tax credits for alcohol fuel production equipment.

4. The Energy Security Act of 1980 (P.L. 96-294), containing additional financial incentives to stimulate alcohol fuels from biomass production, was advancing through Congress with increasing assurance of passage.

5. Demand for gasohol at the pump steadily increased, with the number of service stations throughout the country offering gasohol to motorists nearly doubling.

While conditions affecting domestic alcohol fuels development have changed dramatically, as evidenced by the events described above, these changes and their expected impact on the development and production capacity of the growing alcohol fuels industry were not mentioned or factored into the findings and recommendations of the Report, which was undertaken on a quick turnaround basis. Thus, the ERAB Report, which was based upon data available prior to December 1979, was significantly out

of date due to Congressional and Administration alcohol fuels initiatives which occurred in the first four months of 1980. For this reason, official endorsement of the ERAB Report or support of those findings and recommendations which are inconsistent with the Alcohol Fuels Program could interfere with attainment of the Program's ethanol production capacity goals.

Best available technology is continuing to change with improvements occurring almost daily throughout the alcohol fuel production cycle. This is not all happening at the direction of the Federal Government or the major clients of the Departments involved. The American people have accepted the challenge measured by the rising cost of imported petroleum and are determined to establish viable liquid fuel alternatives.

We will keep both you and the ERAB informed of the progress in reaching our production goals established by the Administration and the Congress.

Comments by the DOE Office of Alcohol Fuels (OAF)

on the

ENERGY RESEARCH ADVISORY BOARD (ERAB)

April 29, 1980 GASOHOL STUDY GROUP REPORT

BACKGROUND

The Gasohol Study Group of the Energy Research Advisory Board (ERAB) was hastily convened at the request of the Under Secretary, and met for two days, on December 10 and 11, 1979. By all accounts, the Study Group agreed upon a number of findings and recommendations at the two day meeting, and issued a draft report two days later, on December 13, 1979. Less than five months later, on April 29, 1980, the Study Group submitted its final Gasohol Report to ERAB Chairman Dr. Solomon J. Buchsbaum with only minor revisions. The ERAB Report concluded that ethanol production would probably reach only 200-300 million gallons per year by 1985, at that rate displacing less than one percent of projected U.S. gasoline consumption. The Report also concluded that by utilizing the "best available" technology expected between now and 1985, the net energy balance is about zero for ethanol produced from corn and other crops in fermentation/distillation plants fueled by petroleum, but that if such plants were fueled by coal or wood, each gallon of ethanol produced could save roughly 0.5 gallons of oil. The Report recognized that gasohol technology is in a continuous state of flux, but is being continuously improved by research in many areas. It made specific findings and recommendations on a wide range of issues, including gasohol energetics and economics, impact on food and the environment, production goals, forestry and agricultural residues, and methanol from coal.

In issuing its Gasohol Report, the ERAB Gasohol Study Group failed to take into account several events which occurred during the intervening period between issuance of the first draft and submittal of the final Report. The following events, which have substantial impact on alcohol fuels development, occurred during this time:

1. On January 11, 1980, the President announced a comprehensive National Alcohol Fuels Program to accelerate domestic production of alcohol fuels from biomass. The program seeks to quadruple January 1980 alcohol production capacity by the end of 1980, and sets a target for domestic production capability of 500 million gallons during 1981.

2. On February 14, 1980, the Secretary of Energy created an Office of Alcohol Fuels to promote ethanol production from biomass, and to implement the Administration's Alcohol Fuels Program.

3. On April 2, 1980, the Crude Oil Windfall Profit Tax Act of 1980 (P.L. 96-223) was signed into law by the President. Among other incentives, the act continued for eight more years, from 1984 through 1992, the four cent per gallon federal excise tax exemption for gasohol; provided new income tax credits for alcohol-gasoline blenders; and extended through 1985 investment tax credits for alcohol fuel production.

4. The Energy Security Act of 1980 (P.L. 96-294), containing additional financial incentives to stimulate alcohol fuels from biomass production, was advancing through Congress with increasing assurance of passage.

5. Demand for gasohol at the pump steadily increased, with the number of services stations throughout the country offering gasohol to motorists nearly doubling.

While conditions affecting domestic alcohol fuels development had changed dramatically, as evidenced by the events described above, these changes and their expected impact on the development and production capacity of the growing alcohol fuels industry were not mentioned or factored into the findings and recommendations of the Report, which was undertaken on a quick turnaround basis. Thus, the ERAB Report was based upon data available prior to December 1979 that was significantly out of date due to Administration and Congressional initiatives in the first four months of 1980.

Following the release of the ERAB Gasohol Report, on May 1, 1980, in a memorandum to the Secretary from E. Stevens Potts, the Office of Alcohol Fuels (OAF) expressed its initial concerns regarding the composition of the Study Group and the objectivity and scientific basis of its Report. Dr. Buchsbaum forwarded the ERAB Report to Secretary Duncan on May 2, 1980.

On May 7, 1980, the Secretary asked the Assistant Secetary 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..." The attached response includes information provided by the Solar Energy Research Institute (SERI), Congressional staff members, the National Alcohol Fuels Commission, EG&G Idaho, Inc., the National Alcohol Fuels Producers Association, and several other groups and individuals.

The ERAB Gasohol Report may have a negative impact on government officials, loan administrators and other financial decision-makers who may not have adequate knowledge of this new industry to put the Report's findings and limitations in proper perspective. These officials, who rely on the government for factual information, may use the Study Group's apparent authority as an excuse for inaction, thus adversely affecting farmers, small farming cooperatives and businesses attempting to compete with their monied rivals for limited capital.

The ERAB Report will have little impact on the major corporations, which are currently expanding the existing gasohol market. Scientists, engineers, economists, and market analysts in these companies are compiling their own data to evaluate the market value of alcohol fuels. As evidenced by the major energy corporations' increasing interest in alcohol fuels, many big companies, such as Texaco (which has made a major and extremely valuable contribution to the nation's gasohol program) and Ashland Oil, are producing or exploring the feasibility of producing this alternative fuel.

The purpose of this response is to present OAF views on several important issues discussed in the ERAB Report and to critique the Report fairly and accurately. It was also necessary to raise issues not addressed by the Gasohol Study Group in order to present the full story of alcohol fuels. In responding to the ERAB Report, it is important to recognize the parameters and limitations of the Study Group that developed the Gasohol Report and to seek a common ground and positive results.

MAJOR CONTRIBUTION OF THE ERAB REPORT

The ERAB Report correctly highlighted several issues relating to alcohol fuels production, such as environmental protection and the potential loss of top soil; the responsibility to provide feed and food to the world market; the need for additional investment protection incentives; and the inadvisability of additional financial incentives beyond those already signed into law. To this we would include measures relating to alcohol fuels contained in the Energy Security Act of 1980 (P.L. 96-294).

SIGNIFICANT LIMITATIONS OF THE ERAB REPORT

The OAF response outlines eight major areas of the ERAB Report which could be misleading and, in some cases, factually incorrect. Despite its contribution, the Gasohol Report did not adequately address:

1. Realistic production estimates;
2. Food versus fuel issues;
3. Net energy balance considerations;
4. Current and projected technological advances;
5. Potential for reducing production costs;
6. The critical need to reduce America's dependence on imported liquid fuel;
7. Problems of methanol compared to ethanol production; and
8. Values and uses of CO_2.

The Report's flaws center around the use of outdated information and the authors' preference for methanol production from coal as well as the conversion of cellulose into ethanol. For example, no reference was made to the fact that a modern, industrial-sized ethanol plant, using starch or sugar feedstocks, can readily accommodate the alternate cellulose substrate with an addition to the front end of the plant. Cellulose simply becomes another source of fermentable sugars to be processed through the ethanol plant. Failure to include the fact the cellulose conversion to fermentable sugars complements the existing ethanol industry, while implying that methanol from coal and ethanol from cellulose are promising technologies, is particularly misleading. In fact, increasing production of ethanol from starch and sugars is developing a market for all alcohols, while providing an industrial base for cellulose conversion.

In responding to the ERAB Report, it is important to recognize that although the basic principles of fuel alcohol production have been known for centuries, many new technologies relating to the production, formulation, and use of fuel alcohol are currently in various stages of development and implementation. The testing and compilation of scientific data for ethanol are still being pioneered by equipment manufacturers, producers, research laboratories, as well as at colleges, vocational schools and other institutions.

The educational process now occurring in the farming, business, industrial and academic world will develop the current and emerging body of knowledge of alcohol fuels into a new field of applied science. Until that happens, opinions and projections regarding fuel alcohol technologies will be only as strong or as valid as the research on which they are based and the actual demonstration of the technology. This is where advances in the areas of alcohol fuels differ considerably from other liquid fuel technologies. There are thousands of conventional as well as "farm, basement and backyard" laboratories and demonstration sites throughout the country where efforts are underway to improve the technology.

Recognizing that there are still too few experts in the field and that our current knowledge is not yet adequate to predict the future of alcohol fuels with complete confidence, it is incumbent on everyone to surface and discuss issues and concepts in a manner that advances science and benefits the nation. That is the spirit in which this OAF response to the ERAB Report was prepared.

1. REALISTIC PRODUCTION ESTIMATES

The ERAB Report underestimated realistic near-term domestic ethanol production capability and thus is inconsistent with the Administration's ethanol production targets as well as those of the Congress. In the Chairman's May 2, 1980 letter to the Secretary, Mr. Buchsbaum stated: "Ethanol production as a near-term (mid 1980's) partial solution to liquid fuels (based on current incentives) will probably reach 200-300 million gallons per year by 1985."

In developing its production estimates, the Gasohol Study Group failed to take into account several Administration and Congressional initiatives, such as the President's announcement of a comprehensive National Alcohol Fuels Program, creation of the Office of Alcohol Fuels, passage of the Crude Oil Windfall Profit Tax Act (P.L. 96-223), alcohol production incentives in the Energy Security Act of 1980 (P.L. 96-294) and growing demand for gasohol at the pump, which had occurred during the intervening period between issuance of the first draft and transmittal of the final Report. These events had a substantial impact on alcohol fuels development and should have been factored into any realistic ethanol production estimate.

With the incentives already in place in July, 1980, the country can reach an annual production capacity of 500 million gallons during 1981, and may be producing as much as five times that amount by 1985. Archer, Daniels Midland, an Illinois company, projects that it will produce ethanol at a rate of 250 million gallons a year by the end of 1981. Thus, one company alone expects to produce the ERAB Study Group's 1985 production estimate by the end of 1981. This was reported to ERAB at their May 1, 1980 meeting.

The Congress, in the Energy Security Act of 1980 (P.L. 96-294), set an annual production target of 920 million gallons of ethanol for gasohol by the end of 1982. In other words, the Congress wants over three times the ERAB production estimate in less than half the time. There are no technical reasons why the Administration's and Congress' production targets should not be exceeded.

2. FOOD VERSUS FUEL ISSUES

The Administration's ethanol production goals can be met without an adverse effect on food supplies or prices. For example, there are significant opportunities to use agricultural and food processing waste products and develop high-yield energy crops for substantial production of ethanol, thereby actually reducing its cost. Further, the ethanol from grain process produces valuable, protein-rich co-products which are suitable for export and domestic use.

Protein Rich Distiller's Meal

The ERAB Gasohol Report [1] focused on ethanol production from grain, and discounted the substantial value of protein-rich distiller's meal, a co-product of ethanol from grain production. Ninety percent of the whole corn sold in this country goes to cattle feed. Similarly, most exported grain goes to developed countries where it is used for animal feed. Thus, for the most part, this grain is not used to feed the world's poor in underdeveloped countries. And in most cases, poor people cannot afford protein from animals fattened with imported grain. [2] At this very moment, our grain elevators and on-farm storage bins are overflowing, with grain stored on the ground. [3] This surplus will likely increase when the new harvest comes in from the farms. Yet people in this country and around the world continue to be hungry and undernourished. This famine is apparently more associated with economics, transportation and geopolitics than with food and feed supplies stored in the United States.

The animal feed market can be maintained and further developed by exporting protein-rich distiller's meal or wet and dry milling concentrates that can be combined with local carbohydrates and forage crops to balance the feed rations. [4,5,6] There is also an abundance of agricultural and food processing wastes that can be converted to ethanol. The co-products of this ethanol production can frequently be used as a new or improved source of animal feed and fertilizer.

Further, there is a major opportunity to use high-sugar, high-starch hybrid plants, such as sweet potatoes or sweet sorghum, that can be double-cropped to greatly increase the ethanol gallonage yield per acre. [7] Again, the co-products from processing these high-yield energy crops can often provide valuable distiller's meal. Under these conditions, a determined and prudently implemented ethanol program will increase rather than decrease the world's supply of high protein feed and food. Further, since distiller's meal is already processed, is in a concentrated form and is cheaper and easier to store and transport than whole grains, it is possible that prices for certain consumer products, particularly meat, dairy and poultry products, can be marketed to consumers at a price fair to them and the farmers. [8]

Many nutritionists express concern that Americans have too much starch and sugar in their diet. [9] In response to this challenge, we have repeatedly seen that creative minds and competitive business, if dedicated to any goal, can find ways

of overcoming barriers. In this case, farm communities and the food industry are already finding ways to deliver valuable co-products, such as oil and high protein bran and gluten from wet and dry milling processes, and distiller's meal from small-scale alcohol production processes, to our tables in appetizing and nutritional forms. [10] We must also, however, recognize our long-term agricultural responsibilities to the world. In doing so, we cannot expect a continuous flow of crops at less than the average cost of production to the farmers.

Perhaps a part of this responsibility could best be met by establishing a "protein reserve" from the co-products of alcohol production, as well as small grains and other foods, that could be more immediately accessible with less spoilage or loss to those areas routinely troubled by hunger. This "reserve" would be more responsive to human needs than to geopolitical or profit motives. [11,12] Every nation must, to the extent possible, develop the capability to produce sufficient food and energy to meet most of its domestic needs. Neither can be supplied indefinitely from outside sources.

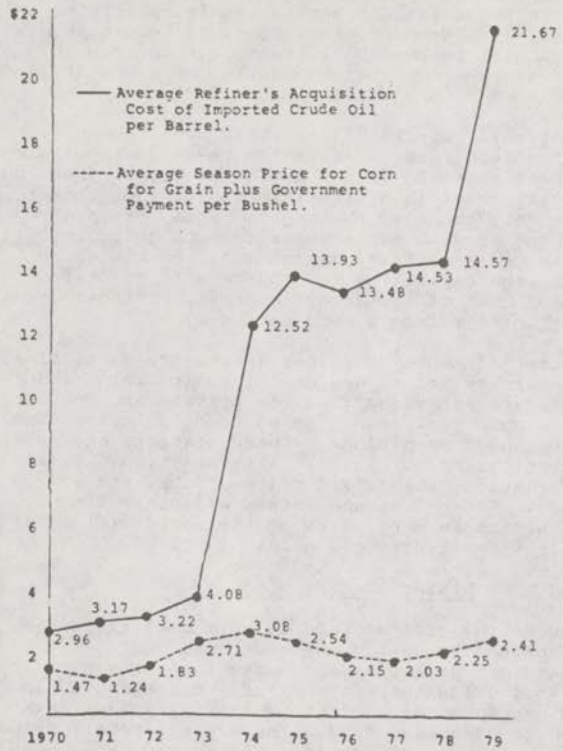
Raising the specter of mounting prices and hungry faces if a portion of the starches and sugars contained in grains and broad leaf plants are separated from the protein and converted into high-grade liquid fuel is not going to help impoverished families, neighborhoods or nations. These starches and sugars are not their critical need. Rather, they need capital, technology, information, stabilized prices, jobs, and simple nutritional foods. Economical and energy efficient alcohol and food co-production in many parts of the world will be of considerable help in meeting those needs.

Rising Cost of Food

In addition, the rising cost of food in this country is far more closely connected to energy and middleman costs -- transportation, processing, packaging and marketing -- than to the price farmers receive for their crops. [13] For example, in June, 1979, the net farm value of the wheat ingredient in a one-pound loaf of white bread was 4.5¢. The average retail price for that loaf of bread was 41.2¢. [14] Since 1970, the price of corn has risen by 55 percent (the market price per bushel of corn was the same in 1978 as it was in 1948) [15] while the price of food bought by consumers has doubled. [16] The escalating cost of petroleum [17] -- a tenfold increase since 1973 -- has affected food prices and placed a substantial financial burden on farmers. (See Table 1 below for a comparison of corn to imported crude oil prices.)

TABLE 1

COMPARISON OF CORN TO IMPORTED CRUDE OIL PRICES



Average Imported Crude Oil Price/Barrel
Source: Energy Information Administration, 1980.

Average Corn Price/Bushel
Source: U.S. Department of Agriculture, 1980.

Limits to Production

The ERAB Gasohol Report used data on increasing population [18] and declining acreage for crops [19] as a basis for its low estimate of alcohol production capability. The Report stated that ethanol production can be expected to reach about 200-300 million gallons per year by 1985 (far less than the Administration's 1985 goal [20] of 2 billion gallons per year) without interference with the world's food supply (assuming current agriculture conditions). However, other estimates (see Table 2) are much higher than this ERAB estimate. It is difficult to determine the basis for the ERAB production estimates which are lower by more than an order of magnitude compared to other reputable estimates.

TABLE 2

SUMMARY OF ETHANOL PRODUCTION POTENTIAL FROM SELECTED SOURCES IN THE 1981 - 1985 TIME FRAME

Source	ETHANOL PRODUCTION POTENTIAL (10^9 gallons) Low	High	Reference
10% increase in grain/ sugar crop production	1.6 (a)	2.7	USDA (b)
Exported corn (20 to 85% used for alcohol production)	0.87	3.7	USDA (b)
Unused Cropland	5.2	8.7	Purdue (c)
Food Processing Wastes	0.5	0.6	DOE (d)
	8.17×10^9 gals.	15.7×10^9 gals.	
ERAB	0.2×10^9 gals.	0.3×10^9 gals.	ERAB (e)

(a) Estimate by Purdue University investigators from "set-aside lands."

(b) Agricultural Statistics, 1978, U.S.D.A., U.S. Government Printing Office, Washington, D.C. (1979).

(c) W. E. Tyner and D.C. Doering, Changing Energy Use Futures, pp. 1825-1832.

(d) The Report of the Alcohol Fuels Policy Review, DOE/PE-0012, U.S. Government Printing Office, Washington, D.C. (1979).

(e) ERAB Gasohol Study Group Report, April 1980.

New Agricultural Opportunities

The ERAB Gasohol Report did not consider, for example, any of the existing and promising opportunities to expand agricultural production by altering cropping practices, such as conservation tillage, 21,22/ and by putting marginal lands into productive use while actually enhancing the environment. In many parts of this nation and the world, there are vast uncultivated acreages suitable for high-yield energy crops such as sweet sorghum, fodder beets, milo, honey locust, cassava, Jerusalem artichokes, manioc and cattails as well as other crops adopted to specific climatic and soil conditions. On the average, productive acreages of corn can be expected to produce about 250 gallons of ethanol per acre per year. Some crops, such as sweet potatoes and fodder beets may be as much as three times more productive than corn. Preliminary data on cattails indicate that two crops of cattails per year can produce as much as ten times as many gallons of ethanol per acre than corn. Pineapple and sugarcane also have attractive productive possibilities. 23/

Further, the Solar Energy Research Institute (SERI) has identified opportunities for major increases in ethanol production through different cropping patterns without challenging the food or feed markets. SERI found the following:

> In animal feed rations, especially feedlot cattle and dairy cows, the nitrogen content of the feed is carefully controlled based on the weight of the animals and/or the stage of the lactation period. Common protein sources for feed rations include soybean meal, cottonseed meal, corn gluten feed, and distiller's dried grains.[*] Of the total protein feed supplement used nationally in 1978, soybean meal comprised 70.8%. However, the ... literature indicates that DDG and DDGS are much more beneficial as sources of protein due to their ability to escape rumen digestion, and thus be more available for absorption by the animal. Although the "concept" of by-pass protein is relatively new, the fact that DDG and DDGS are better in terms of weight gain and milk production has been documented for many years. This is also substantiated by the premium price they command on the protein market.
>
> | | |
> |---|---|
> | Soybean Meal (44%) | $.206/lb N |
> | DDGS | $.290/lb N |
>
> The by-pass value of soybean meal is very low, approximately 28%, while DDG and DDGS have by-pass values of 53% and 38% respectively.

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[*] Editor's Note: It is not necessary to dry distillers grain if it is fed to animals within a few days. Dried distillers grain is usually abbreviated DDG. When DDG is combined with solubles in the stillage, it is abbreviated DDGS.

> Therefore, utilization of corn for fermentation to alcohol should not be looked at in terms of a loss, because the protein is conserved and could be used to replace soybean meal in feed rations, resulting in more efficient feed rations. Instead of using corn for metabolizable energy (carbohydrate), more forage crops would be used. This would result in economic problems for both soybean processors and current producers of DDGS, but supply and demand would take care of this.

There has been a major shift in patterns of crop production in the relationship of soybeans to corn since World War II (see Table 3). With the introduction of large amounts of distiller's meal into the marketplace (about 17 pounds per bushel of corn converted into ethanol), there will likely be a significant shift in the soybean to corn ratio, which will benefit the environment. Top soil loss in soybean production is considerably higher than in corn. It is recognized that soybeans are leguminous while corn is not. However, with prudent soil maintenance programs, including the use of cover crops, corn will be more environmentally enhancing than soybeans.

The ERAB Report made little mention of these important opportunities to stabilize feeding costs and reduce top soil loss as a result of prudent ethanol production.

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TABLE 3

U.S. HARVESTED ACREAGE OF
CORN AND SOYBEANS, 1924 - 1978

Year	Corn (10^6)	Soybeans (10^6)
1924	100.4	0.4
1929	97.8	0.7
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	75.1	63.3

Source: U.S. Department of Agriculture,
Agricultural Statistics, 1979

Strengthening the Family Farm

The United States has a strong agricultural economic base -- our agricultural products provide a critical foundation for this nation's economy and well-being, as well as a positive contribution to our international balance of payments. For too long, this foundation has been sustained, in large part, by the increased value of the farm land rather than by the increased value of the agricultural and energy products raised on that land.

The ERAB Report made only passing mention of one of the major contributions that the ethanol industry will make by permitting farmers to earn profits from the productivity of their land and their own ingenuity rather than from the increasing value

of that land. Farmers see the production of fuel alcohol as a way to generate a steady cash flow and thereby keep themselves and their families on their farms. For example, a small still can generate a cash income for a farming family within four days of installation. 24/ Farm-scale ethanol production provides a viable solution to three serious problems facing the farmer -- rising energy costs, interruption of energy supplies and unsteady cash flows.

3. NET ENERGY BALANCE CONSIDERATIONS

The ERAB Report concluded that "utilizing the best available technology before 1985, the net energy balance is about zero for ethanol produced from corn and other crops in fermentation/distillation plants. If the fermentation/distillation plants are fueled by coal or wood, each gallon of ethanol produced could save roughly 0.5 gallons of oil." 25/

Many technological and energy-saving advances in ethanol production processes are occurring and being implemented at an accelerating pace. Ethanol producers in many parts of the country are realizing substantial energy gains now and expect even greater efficiencies in the near term. As these advances are implemented, the net energy balance of alcohol fuel production will continue to improve.

Energy balance is a non-issue to the extent that domestic ethanol production (utilizing non-petroleum sources) reduces our dependence on imported oil. The U.S. General Accounting Office, in a June 3, 1980 report on the potential of ethanol as a motor vehicle fuel, addressed the net energy balace issue and stated, "There is also a tendency to overemphasize net energy aspects of ethanol as a fuel, thereby losing sight of the real objective: producing usable liquid fuels. For example, using coal to fire the distilleries to process grains and other crops into ethanol may, as some studies show, result in a net energy loss. But the process produces a fuel which is more readily adaptable for certain uses (e.g., motor vehicle fuel)." 26/

Estimated Oil Savings

Based on calculations set forth in Attachment A to this response, each gallon of ethanol produced could save as much as 1.64 gallons of oil, or more than three times the amount suggested by the ERAB Gasohol Study Group. The estimated 1.64 gallon savings may be a conservative figure. For example, at a July 1980 hearing on gasohol allocation before the Economic Regulatory Administration, one major oil company estimated that for every barrel of ethanol used as a gasoline blending component, as much as two barrels of additional gasoline could be produced. 27/

Related Energy Balance Considerations

Although petroleum is now being used to produce ethanol, this will certainly decline as petroleum prices rise and with the advent of improved farming practices, [28] including the conversion of biomass into nitrogen fertilizers using gasifiers and biogas, [29] and the implementation of low energy starch and sugar conversion technologies [30,31,32] currently under development. While not directly relevant to the energy economics of alcohol production, the following two related issues are highly visible to the consumer and may outweigh energy balance considerations in alcohol production: (a) the net energy balance of producing electricity from petroleum and methanol production from coal; and (b) keeping energy dollars at home. These topics are discussed below.

a. Net energy balance in producing electricity from petroleum

If an appropriate end use of petroleum products is to achieve a positive "net energy balance" then it must be remembered that it takes about 3 Btu of oil to deliver 1 Btu of electricity while it takes about 1 Btu of oil to produce 3 Btu of ethanol. Currently, more than 500,000,000 barrels of oil a year are burned to generate electricity. Consumers accept the 3:1 conversion loss in the net energy balance because of the convenience of electricity. However, if the nation requires high grade liquid fuels for internal combustion engines and lower grade liquid fuels for electricity (used for lighting, heating and industrial purposes), the consumer should not be asked to help finance the conversion of a non-renewable, densified form of energy (coal at 12,000 Btu/lb) into a less dense form of liquid energy (methanol at 8,400 Btu/lb) for engine use when the coal can be burned directly in boilers as an oil substitute to produce electricity with a potential crude oil savings of 500,000,000 barrels a year -- unless there are demonstrated economic, energy or environmental savings.

The production of ethanol (11,000 Btu/lb) from a renewable, diversified source -- biomass -- is the reverse of the coal to methanol process; i.e., a dense to a less dense fuel versus a diversified to a dense fuel, with the sun providing the principal source of energy to produce the diversified biomass.

The ERAB Report reflected a preference for methanol from coal, which is best evidenced by the claimed economic advantage of methanol despite the lack of plant reliability data and extended operating experience in this country. Further, the footnote at page 22 of the Report referencing the Mobil Oil MTG process in the Report's description of the coal to methanol process again raises the entire question of conversion efficiency. The ERAB Report accepted a 50 percent efficiency rate in converting coal to methanol. Mobil Oil claims an 85 percent efficiency rate in converting methanol to gasoline.

What is not stated is that the Mobil claim of increasing the energy content of the liquid fuel by a factor of two, by going from methanol to gasoline, is accompanied by a decrease in the volumetric output by more than one half.

Since methanol has many of the same favorable characteristics as a fuel additive, gasoline extender or straight fuel, as does ethanol, it is difficult to comprehend the claims for the energy advantage of the coal to gasoline conversion process.

b. Keeping energy dollars at home

The cost factors of producing or importing energy are especially important to consumers. The energy crisis translates into higher personal energy costs to consumers and inflation caused primarily by the trade deficit arising from the purchase of imported oil. The economical and energy efficient production of ethanol is a way to keep money in local communities and in this country. These measures will stabilize energy costs, stem inflation, revitalize rural America, and create jobs. The American public recognizes that it must be more prudent in its use of both electricity and non-renewable high grade liquid fuels. The use of more visible, locally produced biomass fuels -- growing biomass is a visible process -- will further encourage this favorable move to conservation.

Also, most pioneers working on the alcohol fuels cycle realize that they are in the "Model A" stage of development. They believe that within a few years the petroleum needed in the alcohol fuels production cycle can be reduced to nearly zero, thereby permitting each gallon of ethanol (G) to back out nearly two gallons of imported oil.

4. CURRENT AND PROJECTED TECHNOLOGICAL ADVANCES

The ERAB Report used information which was outdated at the time of the Report's release and which failed to recognize the many technological and energy saving advances occurring at an accelerating pace. For example, projections based on current operating data [33] from Wenger Manufacturing, of Sabetha, Kansas, of a typical 500 gallon per hour plant (plant yield of 2.5 gallons/bushel of corn) indicate the following:

Processing Step	Energy Consumption
Grinding	284 Btu/gallon
Feeding and preconditioning	91 Btu/gallon
Cooking	2641 Btu/gallon
Total	3016 Btu/gallon

This does not include the 8611 Btu/gallon needed to bring the water in the liquefaction tank to 145 degrees F. under current processes, or the heat required for the distillation and distillers meal drying processes. However, much of this low temperature heat can be provided by solar energy or captured from the exhaust or cooling water heat from an internal combustion engine that is being fired by biogas or ethanol and used to drive the extruder.

Also, the use of high temperature yeast; immobilized cells in continuous column reactors; membrane technology or other devices to separate the alcohol, water and salts from the solids before distillation; and the use of liquid to liquid extractors or other low energy distillation techniques as well as vapor recompressors, heat exchangers and water recycling systems, will further reduce the energy requirements in the next few years for the conversion of starch and sugar crops into alcohol, CO_2 and distiller's meal. [34] We can assume that technologically advanced plants may be using less than 35,000 Btu/gal to complete the conversion to anhydrous ethanol in the foreseeable future. [35] This is about 50 percent of the energy requirements cited in the ERAB Gasohol Report (69,000 Btu/gal).

There are also major opportunities on the farming side of the alcohol fuels cycle to reduce energy inputs. Scientifically advanced energy and irrigation conserving farming practices; timely soil, water and biosphere monitoring and analysis; maintenance of the proper balance between micronutrients, micro-organisms and organic matter in the soil; integrated pest management; conversion of biomass into the various solid, liquid and gaseous fractions; the rapid return of manipulated, composted or digested animal, human and crop waste to the soil; the use of cover crops and crop rotation; the optimum use of solar -- passive, active, and photovoltaics, as well as wind, geothermal and low head hydro; and conservation practices in general -- cogeneration, waste heat recovery -- will greatly reduce the energy requirements for growing food, feed, fiber, biofuel, fertilizers and chemical feedstocks.

The ERAB Report said that 45,000 Btu are used to grow the feedstock that will convert into a gallon of ethanol. A reduction to 30,000 Btu of energy required to produce crops that convert into a gallon of ethanol is readily attainable. Not all this 30,000 Btu is chargeable to ethanol. For every bushel of $2.60 corn fermented, it is possible to receive $1.88 for the sale of co-products, and $4.50 for the alcohol. Sale of alcohol represents about 70 percent of the total revenue. Assuming that the energetics of conversion will somewhat resemble the economics, it is possible to charge a significant amount of the energy required to grow the crops to the other co-products. Further, for every pound of corn harvested from the fields, one pound of stover is left behind as waste. If 30 percent of this waste can be removed without negatively impacting soil

fertility and conservation, another 15 percent reduction in the energetics attributable to the production of ethanol is possible. This reduces the energy input for farming to produce one gallon of ethanol to below the 30,000 Btu estimated above.

Basically, the ERAB Report used data from yesterday's agriculture and ethanol production practices, when the cost and availability of energy was of little consequence, to describe an alcohol fuels industry of tomorrow where the cost and availability of energy will be paramount.

5. POTENTIAL FOR REDUCING PRODUCTION COSTS

The ERAB Gasohol Report erred in its analysis of carbohydrate feedstock costs by failing to include co-product credits in its calculations. According to the ERAB Report, "the cost of corn constitutes about 73% of the manufacturing cost of ethanol; hence, process research directed to other areas of cost reduction will have little impact." 36/ (Emphasis supplied) In overlooking the value of the co-products of ethanol production, the Study Group ignored the varied economic factors currently accepted in analyzing and balancing the cost of producing fuel grade ethanol. 37/ Consequently, the economic conclusions and projections arrived at in the ERAB Report are not in step with the economics of current alcohol fuel production technology.

As a contemporary example, the co-products from a wet milling operation are worth $1.88 per bushel, according to the current market value of each, as quoted by Archer, Daniels Midland Company. 38/ The following table is based on current (May 27, 1980) figures:

TABLE 4

WET CORN MILLER'S YIELDS AND ECONOMICS PER BUSHEL OF CORN

Product	Yield lbs.	$/lb.	$/bu. yield
Co-Products			
Corn Oil	1.7	0.235	0.40
Gluten Meal	3.0	0.107	0.32
Gluten Feed	14.5	0.049	0.71
CO_2	15.0	0.03	0.45
Residues & losses	6.8	---	---
	41.0		$1.88
Alcohol			
Ethanol, 2.5 gal.	15.0	1.80/gal	$4.50
TOTAL	56 lbs.		$6.38
Cost of raw corn (May 1980)	56 lbs.		$2.60
Cost of feedstock as percentage of current return value of co-products			40.7%

The market value of corn on May 27, 1980 was $2.60/bushel, according to the Kansas City Board of Trade. 39/

Bushel of corn	$2.60
Less Return value of co-products	1.88
Net carbohydrate cost	$0.72

Based upon the current cost of corn less the current return value of the co-products, the net carbohydrate cost of the 2.5 gallons of ethanol produced from a bushel of corn 40/ is $0.72 per bushel or $0.29 per gallon [$0.72 x 2.5 (gallons of ethanol per bushel -- it is possible to reach a theoretical 2.70 gallons of ethanol per bushel) = $0.29]. If, for the sake of example, the figures in the ERAB Report are accepted as accurate, then the net carbohydrate cost of a gallon of ethanol would be 73 percent of $1.20 per gallon (the ERAB manufacturing cost), or $0.92 per gallon, $0.63 per gallon higher than the $0.29 per gallon arrived at above. Additionnally, if the current cost of corn is used, utilizing the Report's figure of 73 percent of manufacturing cost, this would lead to a per gallon ethanol production cost of $0.40 per gallon, approximately one-third of the Report's estimate (73/100 = 0.29/x, with x = 0.40).

Additionally, if the $1.20 per gallon figure is accepted, then the net carbohydrate cost of $0.29 plus other costs of $0.28 ($1.20 - $0.92) results in a total manufacturing cost of $0.57. Therefore, about 50 percent of the cost of manufacturing alcohol is in debt service, energy, maintenance, supplies and labor -- all of which can be reduced with financial aid from the government and process research and assistance from the scientific and technical community in improving crop growing and conversion efficiencies.

Taken as given, the figures set forth in the ERAB Report lead to results which are misleading when compared to actual current data, as opposed to estimates. ERAB thus overlooks the major opportunities to reduce the cost of producing the feedstock, converting the feedstocks to ethanol and other co-products and developing new markets for these co-products.

The data used in the calculations above were based on actual May 27, 1980 market figures. As of July 25, the price of corn to Archer, Daniels Midland had increased to $3.07 per bushel from $2.60. The value of the co-products has also increased, but not as much; the cost of fuel grade alcohol has remained approximately the same, indicating that the cost of alcohol is not directly geared to the price of the feedstock. Consequently, the cost of the feedstock as a percentage of return value of co-products has risen from about 41 percent to 46 percent. Under these circumstances, the cost of corn still constitutes less than 50 percent of the manufacturing cost of ethanol produced.

6. THE CRITICAL NEED TO REDUCE AMERICA'S DEPENDENCE ON IMPORTED LIQUID FUEL

Advanced Engine Technology

The ERAB Report recognized but failed to address the major cause of the Nation's energy and economic drain which is rooted in the country's dependence on internal combustion engines fueled by refined imported petroleum. [41] The transportation sector accounts for 25 percent of our total annual energy consumption. [42] We use approximately 6.5 million barrels of gasoline a day in the U.S. [43]

If domestic high grade renewable liquid fuels can be produced in this country in the near-term to burn efficiently and cleanly in existing, modified, or newly-designed engines, the economic drain of American dollars to petroleum exporting countries will be dramatically reduced. The Administration's target of 500 million gallons of ethanol production during 1981 will reduce the need to purchase over 18.3 million barrels of oil outside the U.S. at an estimated direct savings of more than a half billion dollars. [44] This figure does not take into account the multiplier effect of retaining capital in local communities and in this country.

Pioneering efforts in the development of new fuel sources will not only reduce dependence on imported oil, [45] but will also help to stabilize fuel costs [46] and stem inflation through the competitive advantages of U.S. agriculture. [47] Keeping money spent for energy in local communities where all citizens can benefit from the multiplier effect is an important consideration in evaluating energy options.

Further, the ERAB Report made no mention of the many innovations coming on line that will significantly increase the combustion efficiency and improve the economics of using formulated alcohol fuels. [48] Alcohol -- both ethanol and methanol -- are simple, one component fuels while gasoline [49], a complex mixture of several hydrocarbons, has evolved and improved during this century. [50] Formulated alcohol fuels, other than for racing cars at events such as the Indianapolis 500, have received little attention and little developmental support. [51]

Now, however, American creativity and mechanical genius are coming into play and engine modifications as well as new designs are appearing all over the country 52/, including: manifold designs; preheaters; fuel vaporizers, injectors and inductors; compression ratio and timing modifications; exhaust recycling systems; and fuel additives and new formulations, as well as other advances such as turbocharging. 53/

In general, current engines can accommodate gasohol and some alcohol formulated fuels. 54/ However, simple and more complex modifications now coming on line will put these fuels in a much more favorable competitive position. 55/ Although the ERAB Report did not address this issue, alcohol fuels (ethanol and methanol) are generally judged against gasoline and diesel burned in engines designed specifically for the latter fuels. We should begin to re-evaluate the value of all alcohol fuels combusted in engines specifically modified or designed for their use so that we can fairly and accurately compare formulated alcohol fuels with gasoline and diesel. A Btu of alcohol does more work than a Btu of regular unleaded gasoline, and on a Btu basis, alcohol blends are generally better than straight gasoline.

Improving National Defense

In the event of a serious curtailment of oil imports, or a major natural or man-caused disaster, an extensive and dispersed alcohol fuels production capacity will be of critical importance in ensuring a steady flow of ethanol to fuel farming equipment, thereby permitting continued agricultural production and distribution. Under the adverse conditions described above, tankers, barges, refineries and pipelines may be of limited value in supplying fuels to farms. Further, by having ethanol immediately available to farming areas, more gasoline and diesel would be available to meet critical, non-agricultural needs. There is precedence for this -- the sizeable fermentation ethyl alcohol capacity that existed during World War II was utilized under emergency conditions to provide the required ethyl alcohol to produce synthetic rubber.

"As the world advances its arsenal of nuclear weapons, it becomes increasingly important that the United States have the capability to withstand a preemptive first strike. It is important to recognize the valuable contribution of a highly dispersed, self-contained liquid fuel production system to serve the vast U.S. farming community in determining the strategic defenses of the United States," according to the Former Chairman of the Joint Chiefs of Staff, Admiral Thomas H. Moorer, U.S.N. (Ret). 56/

The ERAB Report said that "ethanol can be produced on individual farms in small-scale operations and the wet stillage fed to livestock. Although the total energy contribution will probably be small, these small-scale units would offer a degree of family self-sufficiency."

This comment disregards the fact that farmers are totally dependent upon a timely flow of fuel to power farm machinery. When fuel supplies to the farmer are interrupted, seeds are not planted, fertilizers or pesticides are not applied, and crops are left to rot in the fields. Thus, it is not only a matter of energy self-sufficiency, but more a matter of the reliability and continuity of supplying agricultural products which is at stake. In this case, energy self-sufficiency means energy self-dependence. Interruption in imported oil deliveries need not interrupt delivery of domestic food supplies to consumers. A steady flow of food supplies is best ensured when dispersed farm-scale ethanol production is encouraged and the contribution of such production is recognized as essential to our national security. It should be remembered that 11 million cows in the United States produce 15 billion gallons of milk. An equivalent level of ethanol production in the rural areas would go a long way towards making the nation's farms energy self-dependent.

7. PROBLEMS OF METHANOL COMPARED TO ETHANOL PRODUCTION

The ERAB Report touched briefly and only superficially on the environmental problems of methanol and then generally focused on the negative aspects of ethanol production. No mention was made by ERAB that CO_2 buildup in the upper atmosphere will be tempered by alcohol production from biomass (CO_2 is extracted from the atmosphere by growing plants) and worsened by methanol production from coal. A growing number of scientists regard CO_2 buildup as a major environmental problem stemming from the ever-increasing combustion of fossil fuels -- oil, gas and coal.

The major environmental concerns associated with conversion of coal to methanol were mentioned only superficially in the ERAB Report. The Gasohol Study Group must have known that the water needs and waste water treatment requirements as well as the release of carcinogenic materials into the environment are far more serious in the process of converting coal to methanol than in the more benign conversion of biomass to ethanol. Much lower temperatures are needed to convert biomass to ethanol than coal to methanol, for which temperatures in excess of 1000 degrees F. are required. Although these temperatures are not excessive, some scientists are becoming increasingly concerned about the primary and secondary effects of high temperature energy conversion systems. Further, ERAB did not

discuss the management of the sludge generated by coal to methanol as a significant environmental consideration. The ERAB approach of favoring methanol production from coal over ethanol from biomass unnecessarily pits one energy system against another when those systems can and should be complementary. For example, there are millions of acres of non-producing (in terms of biomass) peat bogs in the United States. Peat could be converted into hundreds of billions of gallons of alcohol fuels. The residual high organic material could be combined with mineral rich subsoil, contoured and transformed into productive farmland. Putting this "non-productive" land into food and energy crops could be a major advantage to local communities and the Nation. Further, in stripmined areas, prudent cultivation of energy and food crops will not only produce food, feed and biofuels, but will also develop top soil and restructure the watershed in an environmentally enhancing manner.

The ERAB Report did not consider the production of methanol from cellulose. As reported in the SERI critique of the ERAB Report, this "is particularly difficult to understand in light of the growing body of literature on gasification and methanol synthesis from biomass, and the relatively high feedstock to fuel conversion efficiency of the new process."

It appears that the economics of converting biomass to methanol would favor smaller, community-oriented plants, while the coal to methanol process would require much larger, capital intensive facilities. Consequently, the initial cost to bring production on line will be much higher for large coal conversion plants than for smaller biomass conversion plants, with correspondingly lower capital costs per gallon.

The ERAB Report failed to mention emerging and unforeseen technical problems, particularly the lack of suitable equipment, in the coal conversion process. 57/ Severe operating conditions, primarily high temperatures and pressures, are producing greater corrosion and erosion than was originally anticipated in pumps and valves. 58/ Mechanical failures have been attributed to haphazard equipment development as well as the harsh conditions in the pipes associated with the process. 59/ At this time, cost comparisons between ethanol from grain, a technology commercially available and in widespread operation, and methanol from coal, are suspect. Methanol from coal is still a relatively unproven technology only now approaching the demonstration and evaluation stage in the U.S. Until acceptable plant reliability and extended operating experience are achieved with the latter technology, performance, production and cost estimates are not reliable. However, the engineering delays in the conversion of coal to methanol will probably be overcome by the mid-1980's.

This high-grade liquid fuel, supported by the pioneering efforts in ethanol production, engine conversion and in combustion equipment will make a major contribution to the energy independence of the United States.

The ERAB Report, in discussing environmental factors involved in alcohol production -- ethanol and methanol -- raised the issue of top soil loss. Without question, there is a critical need to protect the top soil, ground and surface water as well as perennial stands of biomass -- ground, bush and tree cover -- which in turn protect the watershed. It is likely that this can best be accomplished through less dependence on energy intensive, chemical intensive, capital intensive and mechanization intensive farming, and an advancement into a more harmonious relationship with nature and an increased appreciation of biological processes.

Hopefully, the improved economics of farming with the advent of the alcohol fuels industry will reduce income pressures and obviate stressed land management practices generally associated with farming under severe economic pressures. This in turn may permit us to proceed with the major task of enhancing the nation's farming environment so that renewable biomass resources will in fact be fully renewable. We should also recognize that in certain parts of the country the production of ethanol from crops will compete with methanol from coal for limited supplies of water. This tradeoff must consider the quality of the water discharged from the respective processing plants. Again, there could well be a symbiotic relationship between the production of methanol from coal and the growing of biomass.

8. VALUE AND USES OF CO_2

The ERAB Report failed to discuss the many uses of CO_2, including its use in oil recovery, [60] storage, [61] refrigeration, [62] food preparation, irrigation water, [63] beverage carbonation, and air or water injection systems to accelerate the growth of terrestial and aquatic biomass. [64] Where markets exist, the current value of CO_2 is approximately $0.03 a pound, [65] and each bushel of corn produces 15 pounds [66] of CO_2 for a value of $0.45. One firm is offering to provide process heat from CO_2 compressors to drive an alcohol plant in exchange for the CO_2. [67] In this type of plant, as well as in many other facilities being driven by waste heat, the actual amount of new energy provided by petroleum fuels is close to zero, being used mainly for lighting and pumps.

EVALUATION OF ERAB RECOMMENDATIONS

Although the ERAB Report is misleading and incomplete in addressing some specific issues, portions of the Report's fourteen recommendations are valid and should be accepted. The following is an analysis of each ERAB recommendation:

1. At this time, we generally agree with ERAB recommendation Number 1 that current incentives for investment in ethanol production are adequate, although it is unclear whether ERAB considered the provisions contained in the Energy Security Act of 1980 (P.L. 96-294) in their recommendation. This combined package of incentives, those currently in place and those included in P.L. 96-294, should be adequate to stimulate the power ethanol industry.

   In order to reduce dependence on imported oil, biomass energy conversion systems should not use oil. Natural gas and propane should be used only when it is clearly advantageous both in dollars and net energy. Petroleum-based fuels should be phased out as coal and renewable energy sources become more routinely used as process heat for alcohol plants. However, in the near term (over the next 4 years), small-scale plants should be permitted to use any form of available energy. It will take about that length of time for the thermal energy industry (which produces boilers, heat exchangers, solar collectors, and kinetic heaters) to shift from petroleum-based fuel to coal and biomass fuels (including methane, alcohol and crop or forest residues), to solar for process heat, and to co-generation. By comparison, the oil companies refine imported oil with natural gas (as a heat source) and are under no pressure to shift to coal or biomass as a process fuel.

2. We disagree with ERAB recommendation Number 2, which sets forth ERAB's estimates of ethanol production, because in developing these estimates, the Study Group failed to take into account several Administration and Congressional initiatives which at the time of the final Report's release had already had a substantial impact on alcohol fuels development. We do agree that "ethanol production... should be allowed to find its own level based on current incentives", when those incentives in P.L. 96-294 are included. The ERAB estimate of 200 to 300 million gallons per year by 1985 may be low by as much as a factor of 10. Ethanol production capability is currently at an annual rate of

more than 130 million gallons; it will reach 500 million gallons during 1981 and may exceed 2 billion gallons during 1985. All available data indicate that the Administration's goal can not only be met, but will be exceeded.

3. We agree with ERAB recommendation Number 3 that tax incentives should be monitored carefully, but this is not necessary to ensure that needed food and feed supplies continue to be available at reasonable prices, as ERAB suggests. Rather, it is because continued monitoring of any incentive is a prudent course. Evidence presented in this response indicates that the Administration's ethanol program will not have an adverse effect on food supply or prices beyond that necessary to strengthen the farm economy.

4. We agree with ERAB recommendation Number 4 that investments should be protected.

5. We disagree with the reasoning of ERAB recommendation Number 5 that additional financial incentives to promote ethanol production should not be implemented (if the need for assistance arises) because of "the likely advent of lower cost alternative liquid fuels such as methanol from coal and ethanol from cellulose in the 1990s." It is illogical to discourage production of high grade liquid fuels, such as currently-produced ethanol from starch and sugar crops, that reduce dependence on imported petroleum now, in anticipation of a future technology. This is true particularly with a technology such as gasoline from methanol derived from coal, which is now approaching the pilot and evaluation stage in Germany (with U.S. participation) and for which performance, productivity and costs are yet undetermined. Additional financial incentives will not be necessary if the ethanol from biomass industry is reaching the production goals set by the Administration and Congress, as expected.

6. We agree with ERAB's environmental concerns outlined in recommendation Number 6. The same recommendation, however, is equally applicable to all synthetic fuels.

7. We believe that ERAB recommendation Number 7 should be augmented by recognizing that assessments of fuel replacement equivalents will continue to be inconclusive until "sound automotive fleet tests" include tests which take full advantage of the special characteristics of formulated alcohol fuels are completed. An accurate survey of consumer experience and preference would also be valuable.

8. While we agree with ERAB recommendation Number 8 that progress toward implementation of other lower cost technologies must be monitored carefully, we disagree with the inference that massive ethanol production should use cellulose as a substrate (see the discussion of food versus fuel issues beginning on page 5). Available surplus and waste carbohydrate substrates have the potential for producing well over 10 billion gallons of ethanol annually without significantly affecting the food/feed market.

9. Although we agree with ERAB recommendation Number 9 that markets should be monitored to ensure that ethanol from ethylene derived from oil is not used to replace fermentation ethanol used for gasohol, we do not believe this is or will be a significant problem.

10. We believe that further research and development is needed, as outlined in ERAB recommendation Number 10, but disagree with the focus of the Study Group's research and development recommendation. Research and development should, in the near term, address increased ethanol production efficiency which will solve many of the environmental and energy concerns. We also suggest that the development of other synthetic fuels be equally researched "on problems of land and water resources and oil and gas inputs" -- including transportation costs to the market.

11. We disagree with the apparent intent of ERAB recommendation Number 11 to favor methanol from coal over ethanol and methanol from biomass. The ERAB Report greatly underestimates the energy and economic potential of biomass liquid fuels. This underestimation is accompanied by a set of conclusions favorable to the conversion of coal to methanol. Such conclusions must await the accumulation of actual performance data of coal-to-methanol conversion and the reactions of the marketplace to a fuel that delivers fewer miles per gallon than gasoline or ethanol. Again, the ERAB approach of favoring methanol production from coal over ethanol from biomass needlessly established a battlefield among domestic non-petroleum liquid fuels when the real thrust should be for energy independence from imported petroleum.

12. We agree with ERAB recommendation Number 12 that favors some government assistance to encourage the production of methanol from coal. Government assistance to all alcohol fuels processes will diversify the sources of liquid fuels to meet transportation needs and to reduce dependence on imported oil. As methanol from coal plants come on line, and acceptable plant reliability and extended operating experience are achieved, reliable performance, production and cost data can be collected and evaluated.

13. We agree with ERAB recommendation Number 13 that world food problems must be considered, in terms of our responsibility to help in alleviating the world food problem. However, we disagree, as indicated in our response, with the assumption that ethanol production means diminished food supplies for undernourished people. There are too many factors involved in dealing with this complex issue to rely heavily on this oversimplified connection.

14. We agree with ERAB recommendation Number 14 that environmental issues relating to the production of methanol from coal should be examined in greater depth and then compared with those involved in the production of ethanol. We note that the ERAB Report did not address the environmental issues of high-grade liquid fuels (alcohol derived from biomass, coal, peat, tar sands and oil shale) as compared to the environmental consequences of converting these energy sources into petroleum-like high grade liquid fuels (syncrude). This omission would be fully understandable except for the Gasohol Study Group's initial appreciation of the coal to methanol to gasoline process -- conversion of coal to a petroleum-like high grade liquid fuel. This early appreciation was later relegated to a footnote in the final Report. We suggest that economic, employment, sociological and consumer preference factors should also be included in this analysis, along with consideration of increased competition in the energy production marketplace that might result from many small firms entering the field as contrasted to fewer and larger energy interests.

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CONCLUSION

The failure to consider significant Administration and Congressional initiatives, as well as other inaccuracies in the ERAB Gasohol Report combine to confuse the public and distract the Nation from a major opportunity to reduce our dependence on imported oil. The ERAB Report used incomplete and outdated information, and its conclusions cast a shadow over a viable future for alcohol (ethanol and methanol from biomass) as well as formulated alcohol fuels. Successful attainment of Administration and Congressional ethanol production goals could be jeopardized by official endorsement of the ERAB Report or support of those ERAB findings and recommendations which are based on incomplete or outdated information. The attached charts highlight some of the main differences between the ERAB Report and this response.

SUMMARY COMPARISON OF ENERGY RESEARCH ADVISORY BOARD'S
GASOHOL REPORT AND OFFICE OF ALCOHOL FUELS' FINDINGS

ITEM	ENERGY RESEARCH ADVISORY BOARD	OFFICE OF ALCOHOL FUELS
1. Realistic Production Estimates	Ethanol production as a near-term (mid-1980's) solution to liquid fuels problem (based on current incentives) will probably reach 200-300 million gallons per year by 1985. Thereafter, about 800 millions gallons of ethanol could be produced per year. This level of ethanol production would displace an equivalent of 26,000 barrels of oil per day, or less than one percent of U.S. gasoline consumption.	When recent Administration and Congressional initiatives are taken into account, ethanol production will meet the Administration's goal of 500 million gallons during 1981 and 2 billion gallons during 1985, as well as the Congressional goal of 920 million gallons in 1982. This would save the Nation 3.5 billion gallons or 230,000 barrels of oil a day, almost 10 times the ERAB projection.
2. Food versus Fuel	Gasohol production will reduce the amount of grain available for meat, milk and egg production.	There are significant opportunities to use agricultural and food processing waste products and develop high-yield energy crops for substantial ethanol production. Protein-rich co-products are suitable for export and domestic use.
3. Net Energy Balance	If the fermentation/distillation plants are fueled by coal or wood, each gallon of ethanol produced could save roughly 0.5 gallons of oil.	If non-petroleum fuels are used for conversion of carbohydrates into ethanol, each gallon of alcohol produced that goes into making gasohol will save at least 1.5 gallons of imported oil.

ITEM	ENERGY RESEARCH ADVISORY BOARD	OFFICE OF ALCOHOL FUELS
4. Current and Projected Technological Advances	Assumes no significant technological advances available before 1985.	Current developments and prospective scientific and technical advances before 1985 and beyond will help the Nation move out of the petroleum era into an energy mix where renewable resources play an important role.
5. Potential for Reducing Production Costs	The cost of corn constitutes about 73% of the manufacturing cost of ethanol; hence, process research directed to other areas of cost reduction will have little impact.	The cost of corn in modern fuel grade alcohol plants will be less than 50 percent of the manufacturing cost of ethanol when co-product credits are considered. Also, other non-grain feedstocks, such as food processing wastes, sorghum, fodder beets, hybrid sweet potatoes, Jerusalem artichokes, honey locust and cassava, will be used to produce fuel and feed. Technological advances, through process research, will reduce production costs and save money.
6. Critical Need to Reduce America's Dependence on Foreign Liquid Fuels	Fails to recognize the potential of ethanol production in reducing dependence on imported crude oil.	Alcohol formulated fuels (methanol and ethanol) will reduce dependence on imported oil, revitalize rural America, reinforce the family farm and strengthen the Nation's national defense posture.

ITEM	ENERGY RESEARCH ADVISORY BOARD	OFFICE OF ALCOHOL FUELS
7. Environmental Problems of Methanol Compared to Ethanol Production	Environmental concerns in converting coal into methanol are minimized while potential top soil loss from an aggressive alcohol fuels programs is emphasized.	ERAB Report correctly identifies some environmental problems, including top soil loss. However, improved farm economics and a shift in crop patterns to more corn and less soybeans will reduce top soil loss.
8. Value and Uses of CO_2	Value of CO_2 is not mentioned.	Where markets exist, CO_2 is a valuable co-product of the fermentation process. CO_2 can be used in oil recovery, refrigeration, in the storage of food and feed, irrigation water, and in air and water injection systems to accelerate the growth of terrestial and aquatic biomass.

Recognizing the significant limitations in actual operating data and experience facing all analysts attempting to define the future of alcohol fuels, it is now time for all parties to pull together to develop all reasonable forms of high grade liquid energy to fuel our transportation system. Ethanol is here now and will hopefully find its rightful place in the Nation's energy mix. In the mid-eighties, when methanol from coal, petroleum coke and biomass come on line, there will continue to be a strong market for ethanol and other biomass-based alcohols. A number of factors such as biomass and coal availability, costs of conversion and transportation, environmental factors and consumer preference will determine ultimate market shares. Producers of alcohol fuels from biomass are prepared to compete fairly, but initially need financial and technical support from the government to compensate for incentives, subsidies and the access to capital from which major oil and energy industries have benefitted over the years.

Senator Birch Bayh, Chairman of the National Alcohol Fuels Commission, recently identified two serious problems hindering alcohol fuels development. "I would like to turn to what I consider the two real impediments to increased alcohol production -- a lack of available funding in the private capital markets and the lack of a clear Federal policy and commitment to alcohol fuels." 68/

The ERAB Gasohol Report significantly adds to those two real impediments by sending signals that are certain to confuse a major segment of the society.

Senator Bayh correctly identified five "facts on ethanol production":

> Fact Number One: "Most of the corn grown in this country is for animal feed, not human consumption."
>
> Fact Number Two: "The causes of inflation in food prices lie not with the American farmer, but somewhere between the farmer and the consumer."
>
> Fact Number Three: "The production of alcohol from corn does not destroy the grain's protein value."
>
> Fact Number Four: "Alcohol production is not constrained by the supply of corn, but by distilling capacity."
>
> Fact Number Five: "The potential for alcohol production using feedstocks beyond grain is vast."

Hopefully, this response and critique of the Energy Research Advisory Board's Gasohol Study Group Report verifies the Senator's five "facts" and we can now move on to address the real opportunities for the nation in advancing formulated alcohol fuels.

FOOTNOTES

1/ Report of the Energy Research Advisory Board on Gasohol, prepared by the Gasohol Study Group, April 29, 1980, pp. 6 and 16.

2/ Foreign Agriculture Circulars FG-7-77, U.S. Department of Agriculture, July 1977 and FG-4-79, March 1978.

3/ "How Investors Can Cash in on Bumper Farm Production", William L. Roberts, Dun's Review, October 1979, p. 161.

4/ "The Potential for Energy Production by U.S. Agriculture", testimony of Barry Commoner before the U.S. Senate Committee on Agriculture, Nutrition and Forestry, Subcommittee on Agricultural Research and General Legislation, July 23, 1979, pp. 3-5.

5/ Grain Alcohol Fermentation By-Products for Feeding in Colorado, Eldon W. Keinholz and David L. Rossiter for the Colorado Gasohol Promotion Committee, Colorado Department of Agriculture, CSU Experiment Station Fort Collins General Series 983, 1979, p. 17.

6/ The Report of the Alcohol Fuels Policy Review, U.S. Department of Energy, June 1979, p. 11.

7/ Fuel Alcohol Opportunities for South Carolina, prepared by Council of Energy Management, Inc. for Energy Research Institute in cooperation with Clemson University, May 1980, pp. III-61 to III-143.

8/ Alcohol Fuels Notebook, prepared for the Alcohol Fuels Workshop III, Colorado State University, March 24-25, 1980, p. 6-6.

9/ Diet, A Key to Health, R. Swinburne Clymer, M.D., Philadelphia, Franklin Publishing Co., 1966, p. 74.

10/ "Human Consumption of Ethanol By Products", Gasohol USA, October 1979, p. 27.

11/ "How Can U.S. Agribusiness Multinational Corporations Most Effectively Help to Reduce Hunger and Malnutrition?" staff discussion paper of the Presidential Commission on World Hunger, Discussion Paper No. 2, p. 2.

12/ "Alternative Development Strategies", staff discussion paper of the Presidential Commission on World Hunger, Discussion Paper No. 3, pp. 5 and 9.

13/ Food Price Inflation in the United States and Other Countries, Report by the Comptroller General of the United States, December 18, 1979, pp. 16 and 23.

14/ Milling & Baking News, October 23, 1979, p. 75.

15/ Crop Reporting Board, U.S. Department of Agriculture, ESCS.

16/ What Causes Food Prices to Rise? What can be Done about it?, Report to the Congress by the Comptroller General of the U.S., September 8, 1978.

17/ "The Downward Pressure on Oil Prices", William M. Brown, Wall Street Journal, February 8, 1980.

18/ County and City Data Book 1979, U.S. Department of Commerce, No. 003-924-01464, 1979.

19/ Potential Cropland Study, Statistical Bulletin, Soil Conservation Service, U.S. Department of Agriculture, No. 578, October 1977.

20/ Fact Sheet, The President's Alcohol Fuels Program, Office of the White House Press Secretary, January 11, 1980, p. 4.

21/ "Tillage and Plant Residue Management for Water Erosion Control on Agricultural Land in Eastern Oregon", R. Allmaras et al, Journal of Soil and Water Conservation, vol. 34, March-April, 1979.

22/ 1980 Guidelines for Minimum Tillage Corn and Soybean Production in South Carolina, Clemson University, South Carolina, p. 2-80.

23/ D. L. Marzold and D. P. Bartholomew, "Photosynthetic Pathway and Biomass Energy Production", Science, Aug. 1979, Vol. 265, pp. 555-559.

24/ David Doyle, U.S. Alcohol Corporation, personal communication.

25/ Buchsbaum letter to Charles W. Duncan, May 2, 1980 transmitting the ERAB Gasohol Report. It is believed that the reference to "0.5 gallons of oil" may be a misstatement.

26/ "Potential of Ethanol As a Motor Vehicle Fuel", U.S. General Accounting Office [GAO], June 3, 1980, pp. 24-25.

27/ Testimony of S.L. McDonald, Atlantic Richfield Company, July 9, 1980.

28/ E. Janeway, Atlantic, Nov. 1979, p. 66.

29/ Farm Journal, April 1980, p. 13.

30/ Ibid., May 1980, p. 24.

31/ Bailey communication to Tarr(DOE).

32/ Stelson (DOE) communication to Hershey.

33/ Gasohol USA, April 1980.

34/ Wall Street Journal, 31 Jan 1980, Meg Cox.

35/ Bio-Energy 1980, Abstract pp. 50,51.

36/ ERAB Report on Gasohol, p. 13, 14.

37/ American Petroleum Institute, Net Energy Analysis of Alcohol Fuels, API Publication No. 4312, Nov. 1979.

38/ ADM communication to Office of Alcohol Fuels, May 27, 1980.

39/ Market quote.

40/ American Petroleum Institute, Net Energy Analysis of Alcohol Fuels, API Publication No. 4312, Nov. 1979.

41/ R. Stabaugh and D. Yergin (edit), Energy Future: Harvard Energy Project, 1979, p. 147.

42/ Ibid., p. 146.

43/ Monthly Energy Review, EIA/DOE, April, 1980.

44/ Ibid.

45/ Fact Sheet on the President's Import Reduction Program, July 16, 1979, pp. 3-5.

46/ Renewable Energy Products, E.G., Sept. 4, 1979, pp. 5, 8-9.

47/ "Food Price Inflation in The United States and Other Countries", GAO (CED-80-24) December 18, 1979, pp. 8, 9, 17.

48/ American Petroleum Institute, Publication No. 4261, p. 17.

49/ Ibid., Table 1, p. 7.

50/ Ibid., Table 1, p. 7.

51/ DOE, The Report of the Alcohol Fuels Policy Review, July 1979.

52/ U.S. Department of Agriculture, Small Scale Fuel Alcohol Production, March 1980, p. II-32.

53/ Council of Energy Management, Inc. Fuel Alcohol Opportunities for South Carolina, April 1980, Section II-D-2, pp. II-93-II-106.

54/ Ibid., p. II-93.

55/ WAG System Brochure, 1979.

56/ Personal communication, June 12, 1980.

57/ Chemical Engineering, June 2, 1980, p. 35.

58/ Ibid.

59/ Ibid.

60/ Amerigas Carbon Dioxide Handbook, UGI, 1979, p. 15.

61/ Ibid., p. 11.

62/ Ibid., p. 11.

63/ Ibid., p. 20.

64/ Ibid., p. 17.

65/ ADM current quotation.

66/ National Alcohol Fuel Producers Association, A Learning Guide to Alcohol Fuel Production, August 1979.

67/ Amerigas personal correspondence.

68/ Speech, May 1, 1980.

ATTACHMENT A

The following calculations set forth the basis for the Office of Alcohol Fuels' conclusion that each gallon of ethanol produced could save as much as 1.64 gallons of crude oil, or more than three times the amount suggested by the ERAB Gasohol Study Group. The U.S. General Accounting Office, in a June 3, 1980 report on the potential of ethanol as a motor vehicle fuel, addressed the issue of inconsistent findings in various net energy analyses, and stated, "net energy analysis is not an exact science; therefore, any two or more studies of a particular energy system can yield vastly differing results, depending on the methodologies, approaches, and systems boundaries selected." 1/ In recognition of this fact, four separate calculations, employing slightly differing methodologies and data, are included in this Attachment.

Calculation I

Although the Btu value of ethanol is about 2/3 that of gasoline, 2/ the delivered mechanical energy of unleaded gasoline and gasohol, rated at the same octane numbers, is generally accepted as approximately the same. 3/ Further because ethanol, under proper conditions, is an octane booster, 4/ it is possible to add ethanol to low-octane gasoline to make gasohol and thus achieve the desired higher octane rating. 5/ This reduces the energy requirements needed to refine higher octane gasoline. 6/ For example, some oil companies are offering gasohol as a substitute for refined premium unleaded gasoline.

Alcohol formulated fuels such as gasohol, which have improved combustion characteristics, will generally deliver better on-the-road mileage compared to gasoline at the same octane level in engines tuned to optimize gasohol characteristics. 7/ Test results indicating less mileage from gasohol were, in all probability, conducted in cars not specifically tuned to accommodate the combustion characteristics of gasohol. No credit is taken for special gasohol tuning in the calculations which follow. Therefore, one gallon of "ethanol (G)" (a term used in this response to describe ethanol blended with gasoline to make gasohol as opposed to ethanol used as a straight fuel or for other purposes) is, at a minimum, equivalent in power output to a gallon of gasoline [gasoline = ethanol (G)]. It is possible to produce those fuels through two different options:

> Option 1 -- Refine about 1.43 gallons of non-renewable crude oil into gasoline. According to Texaco figures, 1 gallon of crude oil will refine into about 0.7 gallons of gasoline with no other fuel fractions remaining.

Option 2 -- Convert renewable carbohydrates into ethanol (G) using about 1/3 gallon of crude oil, based on API-Battelle calculations that 1 Btu of petroleum fuel would produce about 3 Btu of alcohol when nonpetroleum fuels are used in the farming and carbohydrate conversion process to the extent feasible. (If Btu calculations are used, 1/5 gallon of petroleum fuel is required to produce a gallon of ethanol -- see Calculation III).

Accepting gasoline and ethanol (G) equivalency, the 1.43 gallons of crude oil used to refine a gallon of gasoline is reduced to 0.33 gallons of crude oil used to produce 1 gallon of ethanol (G). Further, using ethanol as an octane boosting additive for unleaded gasoline, it is possible to conserve 0.06 gallons of crude oil per gallon of gasoline in the refining process. (The 0.06 gallons saving is an assumed average arrived at by reviewing a large amount of material.) One gallon of ethanol will boost nine gallons of unleaded gasoline to make ten gallons of gasohol. Therefore, it is possible to save another 0.54 gallons of imported crude oil for every gallon of alcohol used as an octane booster (0.06 X 9 = 0.54 gallons). It is now possible to compute the total crude oil back out for every gallon of ethanol (G) produced when using the minimum amount of petroleum in the farming and carbohydrate conversion process: 1.43 + 0.54 = 1.97 gallons of crude oil less the 0.33 gallons used to produce the ethanol (G) for a net savings of 1.64 gallons of crude oil for every gallon of ethanol produced.

Calculation II

An example may be helpful: 10 gallons of gasohol are equivalent to 10 gallons of gasoline in moving an automobile from Point A to Point B. Accepting that it takes 1.43 gallons of crude oil to produce a gallon of gasoline, and 0.33 gallons to produce a gallon of ethanol (G), the following comparisons are possible:

Car 1 driving from Point A to Point B uses ten gallons of gasoline, or 14.3 gallons of crude oil (10 X 1.43).

Car 2 driving from Point A to Point B uses nine gallons of lower octane gasoline and one gallon of ethanol (G) [(9 X 1.43) - (9 X 0.06) + 0.33] = 12.87 - 0.54 + 0.33 = 12.66 gallons of crude oil.

Therefore, one gallon of ethanol (G) saves 1.64 gallons of crude oil (14.30 - 12.66 = 1.64), or 1.148 gallons of gasoline (1.64 X 0.7 = 1.148).

Working the computations in a different manner, it is possible to demonstrate that one gallon of ethanol (G) will save 1.76 gallons of imported oil.

Calculation III

According to the API-Battelle Columbus report, it is possible, under standard agricultural practices, to produce 2.703 Btu of ethanol with 1 Btu of petroleum fuel. On the average, one gallon of petroleum liquid fuel has 134,000 Btu and one gallon of ethanol has 75,670 Btu (lower heating value). Therefore, one gallon of petroleum liquid fuel will produce 362,202 Btu of ethanol (2.703 x 134,000 = 362,202). 362,202 Btu of ethanol is 4.787 gallons of ethanol (362,202 75,670 = 4.787) or, one gallon of ethanol produced requires 0.21 gallons of liquid fuels. (1 4.787 = 0.21). Referring to Calculation I, 0.21 gallons is about 1/5 gallon of petroleum fuel required to produce a gallon of ethanol.

Using the Texaco figure of 0.7 gallons of gasoline refined from a gallon of imported oil, it takes 1.43 gallons of crude to produce one gallon of gasoline. Accepting the octane boost and recovery advantage of ethanol (G) at 0.06 gallons of crude oil per gallon of gasoline produced, it is possible to save another 0.54 gallons [9 (nine gallons of gasoline goes into making 10 gallons of gasohol) X 0.06 = 0.54] for a total of 1.97 gallons (1.43 + 0.54 = 1.97). From this it is necessary to subtract the 0.21 gallons of crude oil used to produce the ethanol (G) for a net back out of 1.76 gallons of crude (1.97 - 0.21 = 1.76). The difference between 1.76 and 1.64 in Calculations I and II results from the 0.33 gallons used in the earlier calculations and the 0.21 gallons used in Calculation III.

Calculation IV

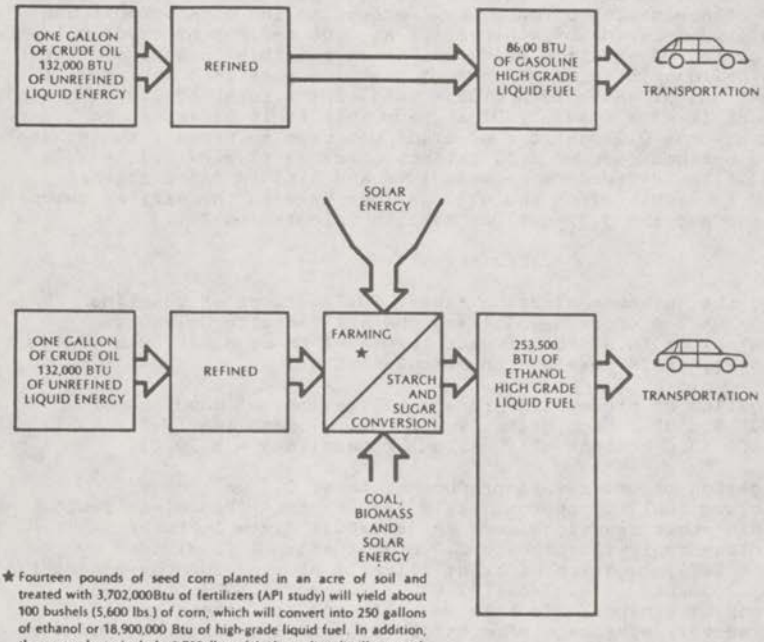
Using the Texaco conversion figure (0.7 gallons of gasoline from a gallon of crude oil) and the API-Battelle Columbus calculations (0.37 Btu of petroleum fuel to produce 1 Btu of ethanol), it is possible to calculate that:

One gallon of crude will produce 0.7 gallons of gasoline or 86,800 Btu of a high grade liquid fuel -- gasoline [0.7 x 124,000 (Btu content of 1 gallon of gasoline) = 86,000].

One gallon of crude will produce at least 0.7 gallons of petroleum fuel, or approximately 93,800 Btu. (Petroleum fuels contain other fractions such as diesel.) Since 1 Btu of petroleum fuel will produce 2.7 Btu of ethanol (1 divided by 0.37 = 2.7), 1 gallon of crude oil will provide for the production of 253,500 Btu of ethanol (93,800 x 2.7 = 253,500), or 3.35 gallons of ethanol. To this we could add the octane boost and recovery advantage of ethanol (G), but the important point to recognize is that all calculations in this new and dynamic industry are based on assumptions that are subject to revision. Therefore, we have used the most reliable data available, such as the American Petroluem Institute's Battelle Columbus study, to reduce the uncertainties.

Regardless of the approach, reducing reliance on imported oil through the production of non-petroleum based high grade liquid fuels is of critical importance. Conservatively then, each gallon of ethanol (G) produced will permit the nation to back out at least 1.5 gallons of crude oil, or 3 times the amount calculated by ERAB.

Finally, these calculations have led to the conviction that we must deal with standard definitions and units of measure -- Btus of high grade liquid fuel instead of gallons, and miles per million Btu instead of miles per gallon. These definitions and units of measure are necessary to avoid confusion in the future. Because of the importance of these factors, the calculations are summarized and simplified in the below graphic:



★ Fourteen pounds of seed corn planted in an acre of soil and treated with 3,702,000Btu of fertilizers (API study) will yield about 100 bushels (5,600 lbs.) of corn, which will convert into 250 gallons of ethanol or 18,900,000 Btu of high-grade liquid fuel. In addition, the co-products include 1,700 lbs. of high quality distillers meal, 1,500 lbs. of CO_2, as well as 20,000,000 Btu of crop residue available for a variety of purposes, including fertilizers. The sun has paid a mighty dividend.

FOOTNOTES

1/ "Potential of Ethanol As a Motor Vehicle Fuel", U.S. General Accounting Office, June 3, 1980, p.24.

2/ American Petroluem Institute, Publication No. 4261, p. 7.

3/ Ibid., figure 10, p. 14.

4/ Ibid., footnotes 38-40, p. 31.

5/ Ibid., footnote 41, p. 31.

6/ Ibid., footnote 36, p. 31.

7/ Ibid., p. 16.

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